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Some Chemical Engineering Aspects of the Silk Industries

By W. F. EDWARDS

Presented at Asheville Meeting of American Institute of Chemical Engineers, December, 1929.

CHEMICAL engineering is usually understood as having to do with the manufacture of chemical products which may include metals and their alloys and by-products of the processes; fuels and by-products such as intermediates and the various more or less purified products made from them; chemicals from a variety of other mineral sources such as salt, sulphur, phosphate and other like mineral deposits; foodstuffs and a variety of other useful products made from animals and vegetables, etc.

The processes of manufacture used to produce these chemical products to be successful must be developed with the best knowledge obtainable of the chemical and physical properties of the raw materials used and of the various transformations taking place in the processes of converting them into the various products desired together with the best engineering skill in devising suitable mechanical and chemical devices for their economical production.

There is very little in the silk industries that fits into this description, but if we enlarge it to include the use of chemicals we shall find a number of the important parts of the processes of converting in which chemicals are used come safely under the term chemical engineering.

Some knowledge of the raw material on which the chemicals are used is essential in order to understand the action of the chemicals in the processes. The raw material is commonly known as raw silk in the market and usually comes to us in bales which are made up of bundles (more commonly called books) of skeins. The Japanese bale, for example, usually contains thirty books of thirty skeins each, the bale containing in all approximately 133 pounds of raw silk when weighed in standard condition, i. e., when it contains 9.91% moisture.

A cursory examination of the skeins of raw silk if they have not been damaged by the use of hooks or other careless handling will give the impression to a novice that it is a very fine product very much alike throughout the bale and to the novice this would seem true for any number of bales ordinarily found in the American market.

A closer examination, however, will disclose that often there are differences in the skeins from different lots or from different bales or even from the same book in respect to uniformity of color, hand or touch, luster, the make-up of the skein and other superficial differences. A still closer examination by suitable means will show that the thread varies in the size and shape of its cross-section, and that it often shows a variety of small loops along the thread, together with varied short thick places and other defects that affect the working quality of the threads.

A brief statement on the production of raw silk is necessary in order to understand the causes of these variations.

Regional and seasonal, as well as day to day climatic conditions, have much to do with the quality of the cocoons used for making the raw silk threads. Cocoons raised in the northern latitudes and in the spring of the year in eastern Asia are usually superior to those raised in southern latitudes or in the summer and autumn.

Cocoons produced under favorable conditions are without much fuzz on the surface, while those raised under unfavorable conditions have a considerable quantity of fuzz. Sturdy, healthy worms under favorable climatic conditions spin the cocoons vigorously and quickly making a nice, firm cocoon, while the sluggish worms under unfavorable conditions spin the cocoons much less vigorously, making a poorer and less uniform thread.

The experienced buyer of cocoons takes the general appearance of certain other superficial characteristics into consideration, and then pays for them on the basis of the amount of marketable raw silk that can be made from them.

The cocoons before storing are subjected to a process

called storing or stifling to kill the chrysalis inside them. This chrysalis would otherwise develop into a moth within a period of two to three weeks, depending on conditions, and the moth would cut the cocoon thread perhaps several times in making its exit. The stifling used to be done by exposing the cocoons to the heat of the sun, but it is now done to a large extent by exposure to hot air or steam. In the hot air process the cocoons spread out in tiers of shallow trays are exposed from three-fourths of an hour to a full hour to a temperature of 180° F. in a well-ventilated room. The live steam exposure is only about one-tenth as long at the same temperature.

Attempts to decrease costs of stifling and at the same time disinfect the cocoons have recently been made by exposing the cocoons at ordinary temperature to noxious or suffocating gases, but so far as the writer is aware none of these attempts has come to commercial success. Such gassing processes may introduce chemical engineering into the silk industry in advance of the filature operations.

Filatures is the name given to the mills where the raw silk thread of the market is made from the cocoons. The single cocoon thread varies in denier size from 1½ to 2½ deniers in Cantons through 2 to 2½ deniers in Cevennes, Syria and Wu Sie to 3 to 4 deniers in Kashing green cocoons and some of the cross-bred cocoons of Japan. The coarsest size cocoon thread is too fine for direct use in the knitting or weaving of fabrics. The filature operation of making a marketable and useful product from cocoons is called reeling and consists in winding the threads from the cocoons and twisting and agglutinating several together into one thread, the number of cocoons twisted together depending on the size of the cocoon threads and the size of the raw silk thread desired. The larger the cocoon threads and the smaller the raw silk thread, the greater chance that the raw silk thread will be of uneven diameter.

Preliminary to the reeling, the cocoons are immersed in hot water to soften the gum which holds the fibers together. The cocoons are brushed with coarse brushes to remove the fuzz and broken parts of the outer strands. The cleaned cocoons are then floated in basins of hot water in front of the reeling machine, and the free ends found and from three to six or eight are placed in the reeling machine which starts the raw silk thread. As each cocoon runs out a new one must replace it so as to keep the reeled thread as nearly as may be the same size throughout its length. A skilled operator, usually a girl, is necessary to watch the thread and to choose the replacement cocoons so as to keep it uniform. There is need of chemical engineering in the filatures to control the quality and temperature of the water in the reeling basins and to control the drying of the threads to give them as nearly as may be the same physical quality throughout the skein and the filature. This is being done to some extent and perhaps as much as can reasonably be expected when circumstances are taken into the reckoning. The reeling of raw silk threads from cocoons is one of the oldest textile industries. Nevertheless, at the beginning of the twentieth century in Japan where large quantities are produced for export it was very largely a household industry wherein the number of reeling basins were for the greater portion of the some 400,000 households reeling raw silk, ten or less. Less than 1% of the total production was in establishments having more than ten basins at the beginning of this century. It will be seen at once that under such conditions there was great variation in the waters used, in the temperature of operation, in the conditions of drying, in the quality of cocoons used, etc. There could be no standardized methods of procedure and control in making the raw silk threads. Moreover it was not essential, as much of the raw silk was woven into fabrics in the same household that produced the raw silk, and the dyeing and finishing were an art that each household prided itself on doing in its own way and better than any other way.

This situation has gradually changed by force of circumstances until at the present time there are several hundred filatures in Japan which have five hundred or more basins; quite a number having one thousand or more basins producing practically all of the export raw silk, which may be as much as 80% of the total production over 90% of which comes to the United States.

It will be seen that chemical engineering methods could not have been practised in filatures to advantage until quite recently when the number of basins became large enough to warrant attempting to have as nearly as practically possible a standard water at a standard temperature with a standard flow and freedom from dirt accumulation from the cocoons.

American requirements for the quality of raw silk have doubtless aided very materially in bringing about better methods of reeling, which means the application of chemical engineering methods more and more in the filatures.

Among the American requirements has always been a demand for raw silk threads of a quality to stand high-speed production. Now in addition we are requiring in many instances that the raw silk thread shall be so even in size and so free from defects that women's stockings can be made so shear as to give the appearance of perfectly smooth bare legs without overburden of seconds in their manufacture.

The raw silk, as it comes to the American market, is not coarse enough for ordinary knitting and weaving purposes, except for a comparatively small portion of coarse sizes used for warps. The silk is changed into coarser sizes by doubling and twisting two or more raw silk threads together by a process known in the trade as throwing.

The first step in the throwing operation is that of winding the silk thread from the skeins on bobbins which are used on the throwing machines. The silk is given a preliminary treatment known as soaking before the skeins are placed on the swifts of the winding machine in order

to soften any hard gum spots and to in general soften and lubricate the silk as an aid to high speed winding and throwing. Soaking consists in soaking the skeins in a warm bath of various emulsions of soap and oil and water.

The great variety of these emulsions and of the modes of their application indicate a fertile field for the chemical engineer, as there is doubtless some emulsion and method of application that is best in the long run for all ordinary silks and throwing operations that could be standardized to the advantage of the throwsters and especially of the dyers and finishers.

Standardization of soaking baths should begin with the water used. There is no valid excuse to-day for bad soaking, due to seasonable changes in waters from streams or differences in well waters in different localities.

Standardization of the soap for emulsions will require investigations of the merits of a very large variety of soaps ranging from the late tri-ethyl soaps which give very stable emulsions with little exhausting power to the very soft and very satisfactory potash-olive oil soaps which are too expensive for use under any ordinary circumstances.

Standardization of the oil content of a soaking bath will require a careful investigation of the merits and demerits of a large variety of vegetable and animal oils, sulphonated oils and mineral oils and complex mixtures of them in a variety of soaking solutions.

The final standards will be standard emulsions to be applied by standardized methods to various types of silks and soakings which would be a great advantage to the throwsters, and, as already pointed out, of especial advantage to the dyers and finishers, and, of course, to the trade as a whole. At the present time it may be said without appreciable reservation that no two knitting mills, for example, have the same requirements for the same purpose. The hundreds of ready-to-use and "trouble-free" preparations offered to the throwsters and continued in the market for use in throwing baths are sufficient evidence of a lack of clear understanding as to a best sane and safe practice in the soaking of skeins of raw silk preliminary to the winding operation.

It is common practice to keep different lots of raw silk segregated as they pass through the throwing mill by the use of tinting. The tinting is done by using fugitive dyestuffs in the soaking bath. These tints and their ways should be given consideration in any study looking to a standardized soaking. Level tinting is not essential but tinting to withstand subsequent operations up to the "boil-off" before dyeing is necessary.

Here again is opportunity for the chemical engineer, as there is no uniformity of practice, the same dyestuff sometimes being quite satisfactory in one mill of a group and unsatisfactory in another mill of the group everything seemingly the same in the two mills but the foreman.

Sometimes when the tinting is the same in two mills, when the spools are taken from the throwing machines, it turns out that one of them is unsatisfactory when the twist is set by steaming, the tinting disappearing in one case. The disappearance of the tint can usually be quite satisfactorily accounted for by the use of too wet steam or steaming in a cold box.

The chemical engineer has opportunity to apply his best skill in another quite important branch of the silk industry which has to do with working up silk waste into spun silk yarns. There are several varieties of silk waste, among which may be mentioned the waste obtained from the brushing of the cocoons in the preparation for reeling in the filatures, waste from broken threads in the throwing operations, and waste consisting of damaged cocoons such as cocoons from which the moth has been permitted to pierce for purposes of propagation, cocoons broken out in the filatures before the whole of the thread has been reeled off, and various other types of damaged cocoons.

The waste from damaged cocoons is worked up into spun silk threads by a series of operations very much like the carding, combing and spinning operations applied to wool. The waste is prepared for these operations by cleaning and boiling off the gum, of which there is a large proportion, in a bath of soap and water after which it is washed and dried preliminary to the picking, combing and dressing operations used to free it from dirt, portions of the chrysalises and other foreign matter, and to bring the fibers into a parallel order after which it is separated into short laps which are drawn out into thin slivers by means of drawing frames, and then thoroughly combed to make the fibers smooth and uniform, after which it is passed through roving frames on to bobbins. These rovings are finally spun into yarns by the spinning, twisting and doubling operations usually applied in spinning woolen yarns.

Standardization of the operations used in preparing the cocoon waste for the carding, combing and spinning operations affords a field for much careful investigation by competent chemists or chemical engineers as to the soap and alkali and washing treatment used in these operations, and might also include investigations as to the possible recovery of the silk gum and chrysalis products as fertilizer or other crude product, as well as the recovery of the soap fat.

There is perhaps no more interesting and fertile field of operations in the silk industries for the chemical engineer than the finishing operations which are largely a matter of careful dyeing. This field is so large and varied that it will be necessary to confine my remarks to some of the more common practices of dyeing silk yarns in skeins, which will serve as an introduction to all processes.

Preparatory to the application of the dyestuff the gum (sericin) is partially or completely removed usually by means of hot soap baths in which the skeins are worked for varying lengths of time according to the result desired. In case of complete boil off, the raw silk loses

from 20 to 25% of its weight, 6 to 8% in souple boil off and 2 to 4% in ecru boil off.

The usual operations for complete boil off consist in working the skeins for an hour or more in a hot 1% solution of sodium-olive-oil soap, using sufficient solution to contain soap amounting to 20% or more of the weight of the raw silk. This is followed by a similar treatment in a second soap bath for about half as long. If pale bright shades are desired, the skeins are placed in linen or cotton bags to protect the fibers and given a third boil off in a bath containing only about half as much soap as the first bath.

A recent modification of the boil-off process is that of working the skeins in soap foam made by blowing air through a hot soap solution. It is claimed that the silk fibers are less damaged than when worked in the solution in the usual way.

The boil off for souple dyeing is made in a weaker soap solution than is used for the complete boil off, and is used at a lower temperature but for about the same length of time. The content of the soap bath is about 10% of the weight of the raw silk and the temperature is usually about 100° Fahr. This boil off is followed by working the silk in a solution of aqua-regia of specific gravity ranging from 1.015 to 1.020 for about fifteen minutes. This is followed by rinsing and sulphur stove bleaching to the required whiteness. This is followed by working the silk for an hour or more in a bath of water containing from three to five parts of tartar per thousand parts of water. This treatment is supposed to soften the soupled silk and render it more absorbent in dyeing processes.

The ecru boil off uses a weaker soap solution than the souple boil off, but is otherwise about the same. After the boil off the silk is bleached in the sulphur stove. The aqua-regia and tartar treatments of the souple process are omitted, leaving the silk with a harsher feel.

The boil-off liquor from the complete boil-off is used in many of the dye baths used for dyeing the degummed silk in amounts varying from 10 to 20% of the volume. This bath is rendered slightly acid by addition of sulphuric or acetic acid which "breaks" the bath, in the parlance of the dyers, and forms an emulsion of silk gum and fatty acid from the soap which emulsion is supposed to have a beneficial effect on leveling and also on protecting the silk fiber.

Much of the silk degummed has been thrown and, as hinted above, the soaking mixtures used in preparing the silk for throwing are many and may contain heavy mineral oils, soap made from hard fats, poorly sulphonated oils and other ingredients which might cause trouble in the "broken" dye bath and interfere very much in obtaining level dyeings.

The completely degummed silk frequently has to be bleached when delicate light shades are to be dyed. Silks with yellow gum are sometimes very difficult to bleach to the desired whiteness by the sulphur stove or the hydrogen peroxide bath. A careful treatment with nitrous acid (sodium nitrite and hydrochloric acid) is usually adequate treatment to remove the last traces of yellow. Here again is opportunity for the chemist and chemical engineer to devise a best method for all-round general use.

The weighting of silk is another much explored field that still has hidden treasures for the chemical engineer. I shall only touch on tin weighting, which is what is commonly understood when weighting is mentioned in connection with silk fabrics.

The process is now worked out so that the common practice may be summed up briefly as follows:

The silk yarn is steeped for a few hours in a solution of stannic chloride of specific gravity 1.250, wrung out, well rinsed in water, and worked for one hour in a bath of sodium phosphate of specific gravity about 1.050, again rinsed with water and soured with dilute hydrochloric acid. These operations are repeated until the desired amount of weighting has been added. In the last repeat the souring is omitted and the operation completed by working the silk for about 30 minutes in a warm solution of sodium silicate of specific gravity, about 1.030, after which it is worked in a soap solution preparatory to dyeing. This reads as if the process was complex, but easy of accomplishment, but, as a matter of fact, the operations must be carried out with care to prevent uneven precipitation on the fiber which would make level dyeing impossible.

It is known that often weighted silks when stored before dyeing (and after dyeing for that matter) undergo decomposition that makes level dyeing impossible. Much research work has been done on tin weighting of silk, but the mechanism of the absorption and decompositions has not been satisfactorily determined. The phosphating part of the process, for example, is not clear though it would at first seem a simple problem in qualitative chemistry.

We have now brought the silk to the point of applying the dyestuffs and the subsequent finishing operations.

It is impossible to give an adequate picture of the problems in dyeing in a paper of this type, and I shall only call attention to the remarkable behavior of silk toward dyestuffs. Almost any dyestuff that can be used on cotton or wool can be used on silk by suitable processes. Silk is more in demand for decorative purposes than any other fiber, and the property of taking on almost any dyestuff under suitable conditions is a great advantage in making numerous combinations desired for decorative purposes.

It will be seen that there is work for the chemical engineer in bringing the raw silk through the various processes from stifling of the cocoons to the dyeing operation that would be done to the advantage of the trade by chemical engineers who were familiar with only the rudiments of the dyeing processes. There is another broaded field in the dyehouses that requires an understanding of these processes in order to understand the material to which the dyestuffs are applied.

Proceedings of the American Association of Textile Chemists and Colorists

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SATURDAY MORNING SESSION

December 7, 1929

THE meeting convened at ten-twenty o'clock, President Killheffer presiding.

President Killheffer—We are late in getting started, so we will proceed immediately with Mr. Johnson's paper on "Sizing Rayon in a Silk Mill."

. . . Mr. Johnson read his paper as follows:

Sizing of Rayon in a Silk Mill

By ARTHUR K. JOHNSON, S.B.
Research Laboratory, Cheney Brothers

THE successful use of rayon in a textile plant involves two general principles. These are:

1. Start the processing with the best quality of rayon which can be obtained for a given purpose.

2. Maintain this quality as nearly as possible in all subsequent operations of manufacture.

Starting with the best quality of rayon may mean: (1) the actual purchase of first quality stock or (2) the improvement of a lower quality stock in two ways, through (a) careful regrading in the mill by rapid skein inspection, sorting skeins into lots according to the relative amounts of imperfections (even removing or correcting yarn or skein imperfections), or (b) through the use in winding of slub catchers for removal of bunched, broken filaments and bad knots.

The maintenance of quality in subsequent processing is accomplished by widely differing methods and to varying degrees in different plants and involves regard for several important factors. Among these important factors may be mentioned:

1. Maintenance of a uniform working atmosphere through all processes including that of weaving.

2. Careful supervision of the condition, set-up and operation of machines, with proper methods and conditions of operation.

3. The building up of a careful and painstaking personnel, or operating force.

4. The development of a satisfactory sizing formula and technique of application. Proper sizing cannot make up for wide deficiencies in these other factors, but, when used in conjunction with these *factors favorably fulfilled*, can be of great service in maintaining the quality of rayon during processing. With this brief suggestion as to the

relative position of sizing in the scale of factors for successful operation, the question of sizing may be opened for discussion.

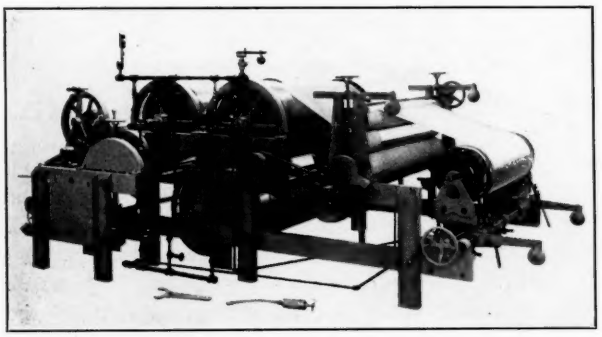
Sizing preparations may be applied to rayons for four general purposes. Three of these we shall but mention in passing, namely, the use of sizing:

1. As a test method for determining the relative absorption powers of the various types, sizes or conditions of rayons under similar circumstances.

2. As an assisting medium in crepe twisting.

3. As a means of obtaining desirable properties in finishing.

The fourth general use is of more immediate concern. It deals with the employment of sizing solutions to help in the preservation of quality during the handling, winding, warping and weaving.



Illustrating methods of controlling tension on (1) *warp beam, on right;* (2) *by synchronizing speeds of rolls and cans, by cone drives, in center;* (3) *by slipping belt tension on winding-up roll, at left.*

Courtesy Charles B. Johnson.

The advantages sought in sizing may be considered under the properties of the sized yarns as:

1. *Ductility and Elasticity = Elongation Is Sum of Ductility and Elasticity.*

Rayon is a ductile material. That is, it draws out into longer fine yarn with tension readily at higher tension. Just previous to a breaking strain it is said to be elastic. Dry values range from 12 to 30%; wet values run higher, with some exceptions. It therefore responds quickly to tension, under increasing humidities. Sizing may reduce the sensitivity of rayon to normal humidity changes and therefore help toward uniform results by diminishing the alterations in rayon under tension in varying humidity conditions.

Sizing may reduce but must not eliminate elongation in the sized yarn as this would imply brittleness which is fatal to successful processing. Rayons having a 20% dry elongation should not lose more than 5 to 7% in sizing (due to stretching) and about the same in weaving, so that a total of not over 12% is lost in the gray cloth.

2. *Strength.*

Except for smaller sizes of rayon (35 to 80 denier) the effect of sizing as a means of increasing the strength of the rayon yarns may, I believe, be considered of minor importance. In the usual qualities and sizes of rayons the yarns have sufficient natural strength to stand the strain of weaving. The actual influence of successful sizing solutions on the strength of the rayon varies considerably with the formula used. In many cases the strength is slightly less than or is merely equal to that of the original yarn, while in other cases it may be increased up to 25% more than the original strength. Increase in strength due to sizing does not of necessity indicate satisfactory working quality in the sized yarns, it may have been accompanied by a deadly brittleness or stiffness.

3. *Flexibility.*

Unsized rayon possesses plenty of flexibility. This property may be reduced in sizing but it must not be eliminated. Lack of flexibility means brittleness, breakage or cutting and most certainly improper working quality. Flexibility is often tested in a sized thread by passing the two ends of a short length of sized yarn by each other forming a loop in the center of the length. As the ends pass farther away this loop gets smaller and finally lost. With a flexibility which is proper for most purposes, this loop will not crack but will maintain its smooth curvature until it disappears, and the thread becomes straight again.

4. *Low Frictional Surface.*

Rayon yarn, undamaged, is naturally smooth and rather slippery. Compared to other types of yarns it has a low-frictional surface which has the effect of increasing its resistance to wear. In sizing this property is maintained by the formation of a smooth, non-granular film around the yarn, or by the presence of lubricants. Both of these conditions tend to increase the resistance to wear caused by rubbing friction.

5. *Cohesion of Filaments.*

This property appears to be extremely important in hard sizing. It means a secure holding of filament position and thread shape in handling and weaving. This has a marked tendency to equalize tension effects on *the filaments and to reduce filament breakage due to uneven tensions to catches and snags on rough or projecting surfaces (such as on skin, jewelry, buttons or machine parts) to rubbing frictions and to cutting edges.* Furthermore, coherence among filaments diminishes the

tendency for broken filaments to keep slipping down the yarn under rubbing friction, thereby forming slubs or bunches which ultimately cause breaks of the yarn or imperfections in the cloth. Coherence, finally, is of material benefit in that it gives a relatively clean break to the broken ends of the yarns, which characteristic reduces the tendency for frayed broken ends to catch on to neighboring threads and bring about further breaks in the caught thread.

In selecting a size all of these factors are looked for.

To summarize, the benefits to be derived from sizing may be grouped to include (1) strength and ductility control as a minor group, (2) low frictional surfaces through smooth film formation, or lubrication and cohesion of filaments (while maintaining flexibility) as a major group.

In selecting a size all of these factors are looked for.

Factors to Consider in Selecting a Sizing Procedure

There may be several sets of factors to consider in selecting a sizing procedure. These may be outlined as:

(1) *The Rayon Material.*
- (a) Its group, regenerated cellulox or acetate, type, size, previous treatment.
- (b) Its intended use as for warp or filling and for what density of fabric.
- (c) Aftertreatment to be given cloth in finishing (dry finishing or wet finishing).

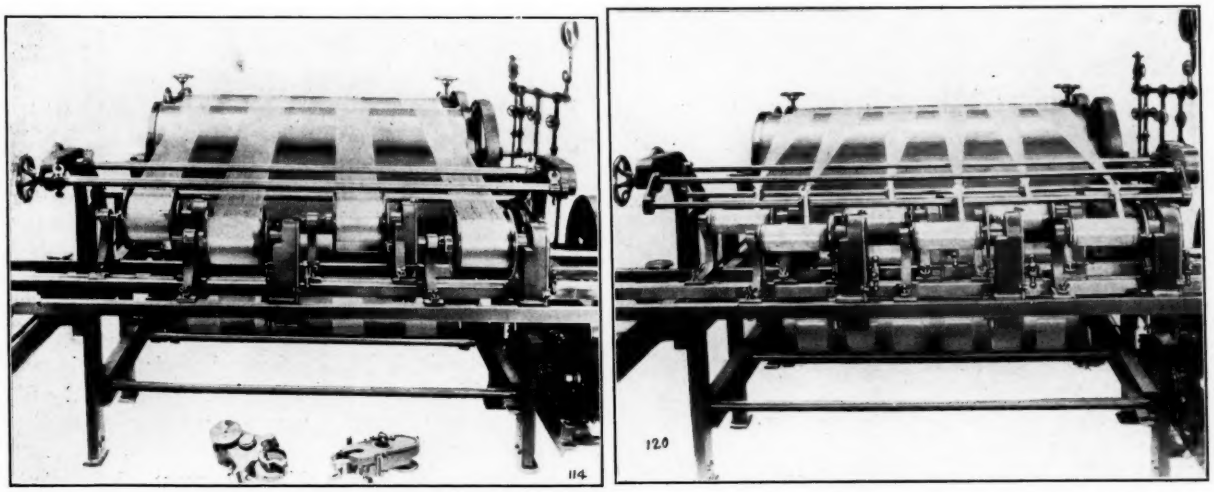
(2) *The Method and Time of Sizing.*
- (a) In skeins.
- (b) As a thread in winding, or from spool to spool.
- (c) As a sheet (prepared warp) on the loom during weaving, or on a sizing machine before being put into the loom.

(3) *The Types of Chemicals Available for Sizing.*
- (a) Animal proteins, glue, casein, albumin.
- (b) Starch products, thick boiling, thin boiling, derivatives, or dextrins.
- (c) Vegetable gums—arabic, tragacanth, seaweed extracts or derivatives, locust bean extract.
- (d) Lubricants and softeners—oils or fats, waxes, soaps, wetting-out agents.

Rayon Materials

The type of rayon to be sized should be known, for there are marked differences in the absorption power of different types of rayon and in the characteristics of the sized yarns when sized in the same solution. The outstanding difference is between acetate rayons and those of the regenerated cellulose type (nitro, cuprammonium and viscose). These two groups are far apart in their behavior toward sizing conditions, the acetate variety being of much greater resistance to size absorption, and therefore requiring special conditions. This must be emphasized.

Among the regenerated cellulose types there are also differences and, furthermore, among products of the same type whether by the same or different manufacturers



Illustrating practical or experimental ways of running narrow warps. It would seem to be an easy matter to put removable partitions into the size trough so that several sizing formulas or several varieties of rayon could be run under identical conditions.

Courtesy Charles B. Johnson.

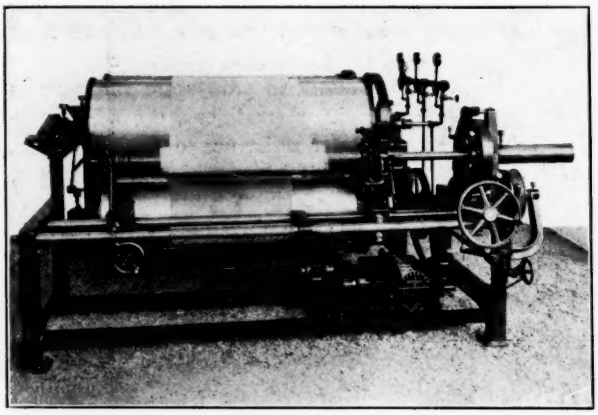
do varying absorption powers exist. These differences are more clearly brought out in the figures given in Tables I and II.

TABLE I

Properties of Various Rayon Yarns (Different Brands) Sized with Same Formula on Johnson Warp-Sizing Machine. 150 D 24 Filaments.

	Viscose A	Du Pont	French V. V. B.	Glantz-stoff
Tenacity ozs./thread...	10.12	9.51	6.84	9.40
Per Cent Increase in Tenacity	24.59	21.15	15.75	23.36
Elongation	16.50	15.47	14.52	10.70
Per Cent Reduction in Elongation of original	33.87	20.86	27.78	30.61
Per Cent Dry Size....	4.10	4.30	3.85	5.70
Per Cent Moisture	10.30	8.80	7.30	7.20

—Courtesy F. G. La Piana, Stein, Hall Co.



Van Vlaanderen Rayon Warp Slasher—Take-Up End

The denier size of the rayon and its filament count are not without importance both in selecting the formula (fluidity, concentration and softness) and the condition of operation (tension and speed) in sizing. The coarser yarns and filaments can withstand more fluidity for better penetration, higher concentrations, more stiffness, rougher handling and higher tensions and speeds. In the finer sizes an effort can usually be made to secure a reasonable per cent of strength increase (15 to 30%).

The previous treatment of the yarn especially as to oiling or waxing (which may interfere with the proper absorption of size from aqueous solutions and materially reduce the cohesion of the film) is very important. When sizing dyed rayon, there must be kept in mind the prevention of undue bleeding and of alteration of shade. With some formulae, alterations in shade is not permanent

INTENDED USE

Another question to consider is that of the position in the fabric which the rayon is intended to occupy; that is, whether it is to be for warp or for filling.

Filling yarns may be sized to assist in reducing the number of broken filaments (or fuzz), slubs, breaks and knots in winding and quilling, and in weaving to reduce the catching effect of the knots, to increase resistance to tension effects and changes in thread shape, to control sluffing and feeding from the quill, and to improve behavior against the cutting or beating up action of the reeds. Filling yarns meet milder conditions than warp yarns and are therefore sized with softer or less concentrated solutions. (One-half to one-eighth strength used for machine sizings.)

Warp yarns present sizing problems varied by the style and construction of the cloth, pile fabrics or broad goods of tight or loose weaves, and either to be dry finished (size left in) or regularly finished (size removed before dyeing).

Pile warps are not usually as dense as broad goods warps; that is, they contain a fewer number of ends or threads. They may be subjected to considerable rubbing chafe in weaving, yet should not slub up or break excessively.

They must feed properly over the rolls, must permit and retain proper filling beat-up, as well as stand up before the cutting knife in good cutting fashion, and be readily removable in finishing so as not to interfere with the proper dyeing or with the opening up of the pile in brushing. They should do all of this in the face of any variations in the natural quality of the warp stock, in the temperature and humidity in the preparation and weave rooms, or in loom conditions. Pile warps may be sized with lubricating soft sizes, or with medium concentrations of stiffer sizes of about one-fourth to one-third the strengths used for broad goods.

Broad goods warps are subjected to much chafing in crowded machine parts, along with good tensions for sustained periods, slow feed, severe beating-up and binding of threads. Wear by the reed or cutting by sharp reed wires may be met. The more dense the fabric is and the more it shrinks in weaving the more difficult the conditions are to meet. Knots also must hold with minimum cutting or breaking. For dry finished goods, likewise for less dense fabrics, a lubricating size may be employed, while for denser fabrics a stronger, more cohesive formula can be applied.

The question of the finishing treatment of the cloth is very important because in yarn dyed, dry finished material (which implies no washing) the size is usually left in the goods and it must not seriously affect the shade, hand or feel, odor or permanence of the goods. It is

usually accomplished with some sacrifice of weaving quality. With regular finishing processes the size is completely removed before dyeing and finishing.

Method and Time of Application

The size may be applied to rayon at various stages during the processing. If not purchased ready sized it may be sized:

1. In the skein (filling, or warp, in gray condition, bleached, oiled or dyed).
2. As a thread (spool to spool sizer) warp or filling.
3. In sheets on warp beams (warps).

Each method of application has its special requirements in machines and solution concentrations, as likewise its special advantages and disadvantages. An interesting series of articles, under title of "Development of Sizing Technique" in the Rayon Record (Vol. II, January-June, 1929, p. 441, 497, 641; Vol. III, No. 1, p. 27), describes various types of machines for sizing rayon. In all sizing machines it is interesting to note the special precautions taken to control elongation (stretch), chafe and heat damage to the rayons. These will be illustrated later in a machine sizer picture.

Interesting Table II shows properties of the same yarn sized with the same chemicals by these various methods:

TABLE II

Properties of Rayon Yarn (150 D 24 Filaments) Viscose Grade A Sized—Skein—Cotton Slasher—Johnson Warp-Sizing Machine

	Unsized Yarn	Yarn Sized	Sized in Cotton Slasher	Sized in Johnson Warp-Sizing Machine
Tenacity-oz. per end.	8.25	9.01	10.11	9.89
Per cent increase in tenacity	..	10.92	22.54	19.88
Per cent elongation	25.30	23.20	19.08	20.80
Reduction in elongation	..	9.17	24.82	17.79
Dry size	..	2.15	4.10	4.80
Moisture	9.60	9.36	8.80	9.00

Sizing formula the same for yarn sized on Cotton Slasher and on Johnson Warp-Sizing Machine.

Sizing formula for skein sizing one-half strength.

—Courtesy F. G. La Piana, chemist, Stein, Hall Co.

From the standpoint of relative costs of handling and sizing, the following table has been suggested, cost increasing from top to bottom:

TABLE III

1. Cheapest—cotton machinery (for production and labor cost)—24 to 36 yards per minute.
2. Horizontal silk warper and Johnson or Van Vlaanderen Slasher—5 to 30 (average 10 to 16) yards per minute.
3. Skein sizing.
4. Spool to spool sizing (20 yards per minute).

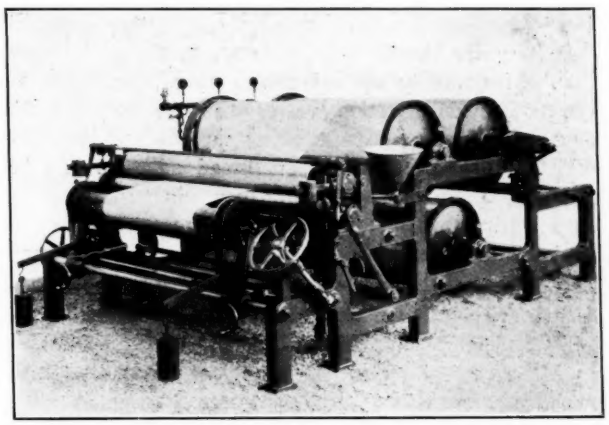
—Courtesy F. G. La Piana.

Skein Sizing

(Wrapped bundle immersion)

(Suspended from rod immersion—carefully done)

Perhaps the earliest and simplest method of sizing is skein sizing. This is accomplished in immersed package form or by supporting the skeins from smooth rods and allowing the free ends to dip into the warm size solution. The skeins may be rotated by hand or mechanically to insure even impregnation. After thorough soaking in



Van Vlaanderen Rayon Warp Slasher—Let-Off End

the solution, the skeins may be drained under tension between two rods in top and bottom of skein, roller squeezed or, preferably, centrifugally extracted. (Squeeze roller extraction as a final one before drying is not satisfactory because of uneven results.) Every effort is made to remove surplus solution evenly. Overextraction, centrifugally, may remove too much size, especially with Celanese. The skeins are then opened out carefully and dried on smooth rods at low heat with occasional rotating movement to keep the size solution from concentrating in the bottom end of the hanging skein. After drying in warm, circulating air the skeins may be conditioned and spooled.

The immersion method of sizing rayon in loosely wrapped bundles, where care is used to insure thorough

impregnation of the yarn with the sizing solution, followed with centrifugal extraction, opening up of the skeins, and drying would appear to be a feasible, less damaging method of skein sizing, than the open skein method, especially for small lots.

Apparatus requirements for skein sizing include the following:

a. Vat or container for hand sizing, or a mechanical sizing machine.
b. Squeeze rolls or a centrifugal extractor.
c. Smooth supports for hanging up the skeins in sizing, opening out and drying.
d. Drying apparatus or room provided with moderate heat (120° to 180° F.) and circulating air, preferably with a conditioning or humidifying box at hand.

The following requirements of a satisfactory skein sizing solution may be enumerated:

1. It should possess good fluidity, hot and cold, for ease of penetration and of uniform removal. Highly viscous solutions do not satisfy these requirements easily.

2. The size should not dry to too hard and horny a film. If unevenly applied and removed, the spots of greater size concentration are very liable to produce hard, bunched places of stuck-together threads. In the dry yarns but slight tendency for thread adhesion can be present. These mean unsatisfactory winding and damaged yarns through filament breakage, yarn tangles, strains and stretches, breaks and knots.

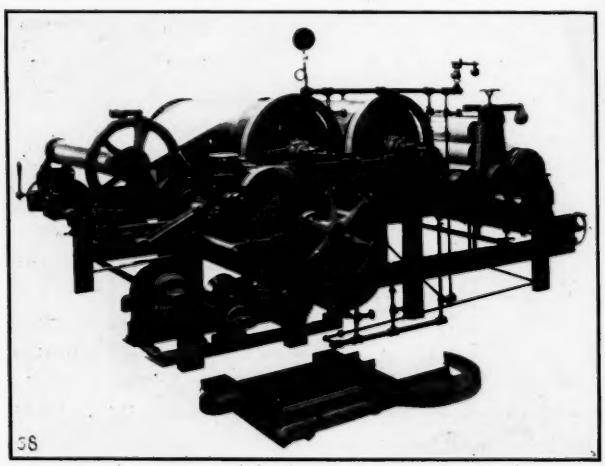
3. The film of size must in general yield filament cohesion, without undue brittleness, stiffness, and with flaxibility and lubricating value.

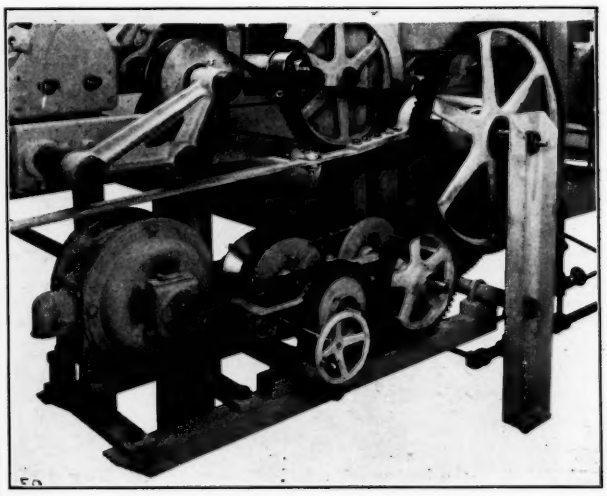
4. The materials must be readily and completely removable before dyeing, or, if put onto dyed goods, must not affect the properties of the dye or the finished materials.

Turning now from requirements to advantages of the skein sizing method, there are several of these. Among them may be mentioned:

a. The simplicity of the procedure, and of apparatus required, especially in hand work, for small lots of materials and for small sizes of yarns.
b. Lower concentrations and less sizing materials may be used.
c. The natural continuity of the process to that of bleaching or dyeing where the thoroughly extracted, moist skeins may be sized, re-extracted, opened out and dried. Less pulling and damaging handling may result from such a combination.
d. The size offers some protection to the yarn in winding, and in some cases facilitates winding.
e. In the building up of warp beams, skein sized, wound yarn makes it easier to secure well prepared, tight or hard beams so necessary to good working on the loom. In stripe effects it also comes in handy to have skein sized yarn.

Along with the advantages of skein sizing are some disadvantages. Relatively low production, long times and labor and attendant high costs for large lots, great tendency for unevenness and for chafing of the yarn, are some of these disadvantages reduced and impaired size absorption on later resizing. Furthermore, there is no particular chance to lay fuzz, slubs, or knots. In other words, the damaged portions originally present in the yarn are little altered by this method. In warping and winding the yarn may be mechanically softened by the film of size becoming irregularly broken down and





Illustrating centering and winding-up tension control of sized yarn, likewise variable speed arrangements.
Courtesy Charles B. Johnson.

knocked off. The film is thus reduced in its resistance to weaving frictions and tensions. If the breaking up of the film is not carried too far such softening may assist better beating up in the loom and yield a softer gray fabric.

The chemicals available for skein sizing include the following used either alone or in combination with others:

a. Animal proteins like glue or casein and perhaps albumen ¼ to 50% in strength, the later for acetate rayons.
b. Vegetable gums and muscilage and modified starches ¼ to 5 or 10%.
c. Oils, waxes and soaps, 1 to 15%. Fugitive stains for identification purposes or dyestuffs for dyeing and sizing in combination may be added at times.

Skein sizing is thus an early, a simple and a practical form for rayon sizing for numerous cases.

Spool to Spool Thread Sizing

A second method of sizing rayon is the single thread method: To a limited extent this may involve a rubbing on of soft size like wax or oil as the thread is being wound from the skein. To a somewhat larger extent it may refer to the spool to spool sizing method. In this method the wound rayon from package creels is guided through the size, then often between rubbing felts, dried by hot plates or hot air and rewound. Tension control must be well looked after as there is more or less of a direct pull on the wet rayon. Winding speeds may at times be kept constant by special speed variation devices to compensate for the increasing diameter of the filling-up spool of sized rayon.

The advantages of this method are: (1) Uniform sizing and treatment with the production of a smooth, uniformly and well-shaped thread; (2) since fuzz and slubs and knots more or less laid low, it tends to produce a clean looking, uniform thread; (3) size consumption is low, and (4) ready supervision of each thread is to be had. Disadvantages may be: low production, high cost and strained (stretched) threads.

Warp Beam Sizing

The most economical method for sizing warp rayon is believed to be in sheets on a warp beam, a few hundred to several thousand parallel ends forming the sheet.

An interesting application of this method is for the sizing on the loom by having the previously unsized threads run from the loom beam, in frictional contact with rolls of soft, fat or wax sizing materials. This method is said to have use in Europe. The resulting yarn has a lubricated condition with slight sticky coherence of filaments and softness. It would appear to be best adapted to use with coarse yarns or where a soft size to be left on the goods is desired.

A more frequent method consists in applying sizing on mechanical sizing machines. While in cotton mills these machines may be modified cotton slashers, in silk mills they are most frequently special rayon sizing machines similar to the Van Vlaanderen or the Charles B. Johnson warp sizers. In these machines (See Fig. 1), the rayon comes off from a tensional warp beam, is threaded over rolls going finally between a positive driven, size-bearing roll and a top pressure roll where the size is applied. The sized, wet rayon then goes onto dry cans driven at a controlled, synchronized speed so that barely enough tension is applied to the wet yarns coming from the rolls to keep them taut. The dry cans are kept at as low a temperature as will dry the yarns at the given speed of operation. The first and last are of low heat, the middle one of higher temperature. For acetate yarns the first can is often wrapped, and all temperatures kept low. The standing of acetate rayon on hot cans is reduced to a minimum. When the yarn has come off the drying cans it is wound warm and dry onto the centered weaving beam in hard fashion. Particular attention should be paid in machines of this type to tension. Excessive tension means excessive stretch or elongation. Too much elongation in the yarn here means a lowered residual power of elongation for the weaving and finishing with resulting breaks all along the line. Tension is controlled by weighted brake straps on the drums of the warping beam, by the control of relative speeds of sizing rolls and dry cans and of the loom beam receiving the sized yarns. The tendency for increase in speed of the building-up roll is automatically taken care of by belt slippage of the winding-up roll drive. Squeeze roll pressure at time of sizing is of great importance in affecting uniformity of size application, quantity put on and its penetration.

The machine sizing solution should be uniform and fluid, of good carrying power on, and inert toward, the supply roll. It should easily wet out and be absorbed by the dry rayon, should yield a non-granulating, non-sticky film for the dry cans and should give considerable filament coherence with minimum thread cohesion and only reasonable stiffness.

Machine sizing possesses the advantages of yielding good production, a good grade of sizing with minimum mechanical damage to the yarn and the building of hard beams for weaving. An unbroken sizing film is presented to the loom. Production is flexible for changes in requirements.

Certain disadvantages include (1) the tendency to flatten large knots and slubs so that their size is not diminished and breaks in weaving where these occur in the

stock are rather certain; (2) the need of eternal vigilance to regulate operating conditions, prevent broken threads from winding about the moving parts and yield a sized beam of proper physical form and density; (3) inconvenience and losses when a beam happens to be spoiled or damaged.

Chemicals Available for Sizing

In the selection of chemicals suitable for use as sizing agents thought is given to:

a. Their ease of getting into solution and the stability of the solution in use and in storage.
b. The behavior of the solution in application (feeding up, wetting out and penetration power, drying qualities and tendency to adhesion and the character of the dried film on the yarn.
c. The difficulties of removal after weaving.

Favorable qualities to all of these will naturally include ready preparation of the solution, good stability, good feeding up qualities with quick wetting-out penetration and absorption. The dried film should be non-granular and smooth, flexible (not brittle or too hard) and of good strength. It should impart minimum thread adhesion and good filament coherence. The size should be easily and completely removable before dyeing. There are several groups of chemical substances which are variously used for rayon sizing. These are:

1. Animal proteins, glues, casein, albumen. These tend to give a rather tough, hard, brittle film, smooth and transparent, imparting good strength and fair cohesion. Their action must be softened down in actual use. This group appears to be as favorable as any for acetate yarns.
2. Carbohydrates:

    a. Starches.
        1. Thick boiling, not particularly satisfactory without thinning.
        2. Thin boiling, by acid or oxidizing agents.
        3. Dextrins, variable but fair in quality.
        4. Derivatives—excellent.
    b. Sugars-glucose.

This group is variable in the satisfaction given. Certain members, notably group a2 and a4, are of good service giving good cohesion and strength with a smooth film. Softening is usually required.

Vegetable Gums (Some Are Carbohydrates)

a. Gel forming extracts, like moss or seaweed, alginates and Locust Bean extracts.
b. Gum arabic. This group is of limited service—some members of questionable value.

Lubricating, softening or hygroscopic agents—emulsifiable oils, fats or mineral oils, soaps and waxes—these agents may lubricate when in sufficient quantity as in soft sizes, while in stiff sizes they remove the harshness of the film, increase its pliability and tend to reduce its cohesive power and strength. Hygroscopic agents, usually organic liquids like glycerine, ethylene glycol, themselves soften the film while their slight increasing of the moisture content improves the pliability of the yarn. Wetting-out agents for oiled yarns or for acetate yarns have some value in improving the uniformity and amount of size absorption.

By judicious selection of the kinds and concentrations of materials like the above, it is possible to obtain a rayon sizing mixture which will give reasonable results for the common conditions of winding, warping and weaving. Such selection requires much "scouting around" or experimental trials.

Laboratory Sizing and Testing of Sized Yarn

The behavior of sizing solutions may be observed under practical conditions in weaving and finishing. Results are obtained by personal experiences of operators, and, more definitely, by weaving studies by recording results in dyeing and finishing, and finally by careful inspection of the finished cloth (as to freedom from yarn imperfections, slubs, knots, streaks, evidence of poor beat up, fuel). This takes a long time from the sizing of the warp to the examination of the finished cloth. If the size proves satisfactory, all is well, but if there is evident need for a change, what then? The practical method as a means of experimenting, except in final confirmation of selected experimental results, is slow and costly. Witness the delays in scheduling and operation, cutting of unsatisfactorily sized warps out of the loom, resizing and replacing. Likewise the practical method is open to a considerable experimental error owing to the impossibility of controlling conditions with sufficient exactness, due to natural variations in warps, machine conditions, and the production atmosphere. Hence it is very desirable to be able to obtain preliminary information concerning the characteristics imparted by a sizing solution in a rapid, inexpensive, but reasonably accurate way. This saves the practical tests so necessary as a final point for judgment for use with picked formulae. Such a rapid method may be devised for laboratory use.

In laboratory sizing there are at least two economical plans possible. One is skein sizing, followed by extraction (not wringing), opening out and drying. This serves very well for judging the qualities of a solution for mill skein sizing and for showing the thread adhesion tendencies. It has not been found to be so satisfactory for

testing solutions to be used on spool or warp-sizing machines.

A fairly satisfactory method to show machine-sizing qualities is a single-thread sizer. In this, yarn is drawn end off from a spool through a sizing solution by immersion between two rubbing felts into, or across, a drier and onto a winding device. In an inexpensixe application of our own, one yarn reel supports the spool bearing the unsized rayon, furnishes the motive power for operation when receiving the sized yarn which it winds into a skein. Drying is accomplished by running the yarn into a hot air drier, over a revolving swift and back out again to the reel. The size solution temperature is regulated by a hot sand bath. If skeins of known length are wound of the unsized yarn run on the machine through water only, and of yarn run through the size solution, then by a comparison of the weights of the two skeins exposed to similar humidity conditions can the percentage size taken up be determined. With low viscosity sizing solutions, this machine gives very comparable results on repeated tests and furnishes a very fair index of the probable behavior of a sizing solution when used in the sizing machine.

The character of the sized yarn is judged from its behavior on (1) looping (pliability or stiffness), (2) breaking (brittleness, strength, and condition of fray on the broken ends of the yarn) and (3) rubbing or cohesion (on thumb nail or frictional rubbing), (4) percentage size retained and (5) effects of weaver's knots when pulled.

An ideal machine is a narrow spool sizer. This embodies much the same principles as the laboratory machine. It has a spindle rack for revolving spool, a sizing pan for yarn immersion, friction felt pads for removing surplus size and laying imperfections (slubs, filaments, knot ends) a hot plate or hot air drying apparatus and a power driving winding creel. The spools in winding the sized rayon provide the motive power for running the rayon. With such a machine it is possible to test several spools of the same or different sizes, filament number of kinds of rayon at the same time, while the operator is free to observe all that happens. The sized yarn for testing is taken from the spools.

President Killheffer—The time having more than expired, we let it run over because we started a little late. If there are any questions that anyone would like to ask or something further they would like to say, now is the time to do it. We will have a few moments for discussion on the paper that has been presented. You understand, of course, where it is necessary to cut the presentation of the paper itself, the entire paper will later be published so that it isn't quite as harsh or as rough as it may seem.

Karl M. Herstein—I would like to say a few words about the quick examination of the sizing preparation. I had occasion a year ago to examine quite a number of them. I observed that the commercial preparation, which has almost infinite variety, appears either as dry powders or as paste and the simplest way I found for making a rough comparison very quickly was to dissolve them up in solutions of approximately the same strength, place a few drops on a microscope slide, dry them in an oven at 100 degrees for, say, half an hour, and you get a film on the miscroscope slide that is a magnified example of the film you get on a bit of rayon yarn. You can examine it more closely, observe its brittleness or flexibility, and the most important thing about it when you make your examination, you can just stick that microscope slide in a dipper of water and observe the readiness with which the size washes off and that, from the standpoint of the finisher, is a particularly important characteristic of the size.

I observed very great differences in the readiness with which the sizes washed off. Of course, a finisher wants one that will give the yarn good characteristics in working, but when he comes to his part of the game, he wants it to get out of the way quickly so it won't interfere with further operations.

Paul J. Choquette—Mr. Herstein more or less anticipated my question. I wanted to ask Mr. Johnson to what extent he found laboratory means of testing applicable to plant practice, how they checked up methods such as Mr. Herstein mentioned.

Mr. Johnson—I think that for the testing of submitted samples, it gives you a fair indication; with a single thread sizer we have developed, we can get a fairly good idea, having had a chance to check up the characteristics of the sized yarn with actual behavior in weaving. As soon as you have a chance to do that, you get a very fair indication of how the size will probably run, both on the machine and in weaving. I think that without the opportunity of correlating the characteristics of your laboratory sized yarn, we will say, with machine sized yarn, in weaving, it will not be altogether satisfactory. Certain sizes will appear to give a good-sized thread, but these do not weave at all. This means that the final test, the thing which we use as a last step in our testing of a size, is an actual machine size and weaving. You can, however, eliminate quite a number of solutions by results with your original thread sizer (or skein sized in your skein sizing test). I have also used the dried film method to a certain extent, but haven't given it the thought that is evidently suggested be given to it.

Mr. Choquette—Have you ever made efforts to measure the amount of penetration, the appearance of the size on the yarn under the microscope?

Mr. Johnson—No, we haven't. We have tried other

machine methods of studying the characteristics, but we haven't made any detailed microscopic study of the distribution of the size in the yarn.

President Killheffer—Your first question had to do, as I understood it, more with laboratory preliminary determinations to indicate what you should go on a little further with. If that were so, then I think Mr. Herstein's proposition probably had a direct connection with your question.

Is there anything further on this subject of rayon sizing?

. . . Mr. F. G. La Piana, of Stein, Hall & Co., Inc., read his paper as follows:

Practice of Rayon Sizing in American Mills

By F. G. La Piana, Ph.G.

Technical Service Department, Stein, Hall & Co., Inc.

IN weaving cloth the warp of which consists of rayon yarn it is necessary to size the rayon fibers so that they will withstand the friction and chafing of the weaving operation.

Rayon yarns are made up of numerous and continuous fine filaments very lightly twisted together (ordinarily two and one-half turns to the inch). These filaments taken singly are very weak and break very easily when rubbed against hard or rough surfaces. Therefore they must be banded together and must be covered with a protective coating so that when going through the reeds and the harness they will stand the friction without breaking and fuzzing up. This is the chief object in sizing rayon yarn.

Elongation and Critical Point of Yarn

In sizing Rayon fibers another property of the yarn must be kept in view constantly. Under tension these fibers elongate very much like natural silk; as a matter of fact, it would not be very far from the truth to say that the processing qualities of the yarn are determined by the percentage of elongation. Furthermore, when this yarn is elongated under tension a point is reached at which the yarn loses its shape and strength. This point varies according to the different brands and grades of rayon, but is close to 50% of the total elongation at the breaking point. This critical point must never be reached for successful weaving and finishing of rayon cloth. In the sizing operation the yarn is subjected to more pulling and stretching than in any other operation. Great care must therefore be exercised to keep the regain in yardage to a percentage well below the critical point.

Another factor in the sizing of rayon yarn is its weakness while wet. This property necessitates very careful handling of the yarn from the moment it enters the size bath until the excess moisture is driven off by drying.

Necessary Properties of Rayon Size in General

In sizing cotton warps, a more or less thick solution of starch is used which has sufficient penetration properties to ground itself well on the fibers. At the same time the size should tie in the small protruding fibers with a flexible film. Rayon differs from cotton in that the filaments are continuous and therefore only need to be held together in one thread. A very thin size must be used to get a thorough penetration between the filaments, making them adhere one to the other and giving the yarn the property of a clean-cut break. The film produced by the size must be pliable, and tough but not brittle. Rayon sizing must give a transparent film, particularly in sizing skein-dyed yarns. Anything that affects the natural luster of the yarn is objectionable.

Our experience has been that the proper amount of size varies from 3 to 5% of the weight of the dry yarn. Warps for materials that are sold and used direct from the looms—e. g., some draperies, bedspreads, etc.—are sized very lightly, while goods that must be desized and finished after weaving may be more or less heavily sized according to the amount of friction they will be subjected to in the loom.

Another important feature of a rayon size concerns its desizing qualities. Rayon fibers, as we said above, are very weak in the wet state and therefore cannot be subjected to any harsh treatment in the desizing operation. Still all the size must be completely removed if perfect dyeing is to be obtained and a soft silky finish given to the fabric. It is therefore important that the size be of such nature that it will dissolve and wash out as easily as possible without the aid of strong chemicals or the use of prolonged high temperatures.

Moisture

High temperature must be avoided in drying sized rayon so as to retain in the yarn approximately its original moisture, which is about 10%. Of course, the temperature used depends upon the denier of the yarn, the number of ends in the warp and the speed of the sizing machine.

Temperature of Sizing Bath

A variety of opinions exist as to the proper temperature of the size bath. Some mills obtain very good

results with temperatures ranging from 120° to 140°, others use temperatures as high as 150° to 170° F., and still others use their size below 100° F. For dyed yarns the lower temperatures are more appropriate. The necessity of using rather low temperatures in sizing rayon is one of the reasons why the sizing material must stay fluid and thin.

Skein Sizing

In sizing rayon skeins particular attention should be given to the viscosity of the size. Only very thin solutions should be used composed of materials which, while adhesive enough to hold the filaments of the same thread together, when dried will not glue the threads so strongly that it will cause breaking of the filaments if the skeins are shaken and the threads separated one from the other. If the size is thin enough, a few turns of the yarn in the size bath will be sufficient to get the desired results. The surplus of size is best removed by hydroextracting. The practice of wringing the skein is faulty, as it causes very uneven stretch and breakage of filaments. For skein sizing, low temperatures are preferable, especially with skeins dyed with direct colors.

Warp Sizing

In preparing rayon warps for the loom beam, two methods are generally used in this country—one, broadly speaking, might be called the "cotton method," the other the "silk method." In the first method the rayon is transferred from the skein to the spools and from the spools to the warper beams. Each warper beam contains from 300 to 600 ends. The yarn goes directly from the warper beam to the slasher. In this method the cylinder slasher for cotton warps is used. Generally, only the larger of the cylinders is employed, the small cylinder being eliminated. The warper beams are placed in a horizontal position at the back of the sizing machine on a frame slightly inclined so that the first beam will be at the same level of the size box, the next an inch or so higher, and so on. The necessary number of beams, depending on the total number of ends in the warp, are placed in position. The yarn is run from each warper beam directly into a warper comb fixed in front of the size box, one end from each beam in one dent. Since the beams are placed on the frame at different levels, the yarn from the higher beam does not touch or rub the yarn from the lower beam. Weights are attached to the flanges of the beams to keep the unfolding of the yarn at a uniform tension. From the comb the yarn is guided into the size box. In some of the mills the yarn is immersed in the size as is done with cotton; in some others the yarn is taken directly through the nip of the two rollers. The lower of the rollers, made of copper, rotates in the size; the top roller, or squeeze roller (which may vary in weight according to the denier of the yarn being sized), is covered with flannel on a base of burlap. The copper roller should not be covered. From the nip the yarn is carried over the large drying cylinder to the guide roll, and then through as many split rods as there are section beams to the take-up rolls, and to the loom beam. It is to be noted that this method is prevalent throughout the Southern mills. The operatives of these mills are used to cotton machinery and seem to prefer it to any other. There is no doubt but that they are obtaining satisfactory results.

On the other side, most of the Northern mills prefer the so-called "silk method." These mills have adopted the new rayon slashers. In this method the warp is beamed on the horizontal warper, and consequently the sizing is done from beam to beam. Proper tension is applied to the let-off beam for uniform release. On this type of slasher the size pan is smaller than in the regular cotton slasher and the yarn is never immersed in the size but is run through a three-roller quetsch. It is first passed over the top roll and then back between the top and central roll, and then again between the central and lower roll, and from there to a set of three drying cans. The sizing solution is applied to the yarn by the action of the bottom roller, which rotates in the solution pan and brings the size up in the nip between the middle and the bottom rollers. There is an evident advantage in this method due to the fact that the pulling of the warp from the let-off takes place when the yarn is still dry at the nip between the top and middle rollers, and so excessive stretching of the yarn is eliminated. The three drying cylinders are much smaller than the one large cylinder of the cotton slasher and the temperature can be regulated in each one of them separately.

Sizing Materials

Dextrines and Starches.

Dextrines and starches more or less modified are sometimes used for sizing rayon. Dextrines have a tendency of making the yarn stiff and brittle; and starches, besides their high viscosity and the opacity of their films, require special treatment for complete removal in the desizing process. The amount to use depends largely on the degree of conversion or degeneration of the starch molecule, as this determines the viscosity of the solution.

Natural Gums: Tragacanth, Locust Bean Gum, Gum Arabic, etc.

Solutions of these products cannot be made quickly, and they have to be very carefully strained to eliminate lumps and gritty matter. Tragacanth and Locust Bean gum make a very thick paste at a concentration of 4 or 5%, and these pastes have to be greatly diluted before they can be used for sizing and in consequence the resultant film is very weak in adhesive qualities. Gum Arabic is more suitable, due to the viscosity of its solution, but the film is harsh and brittle.

Gelatines and Animal Glues.

The earliest sizes for rayon were made out of these materials. Only the finest grades of gelatine and glue can be used, and, of course, these are very costly. The addition of glycerine and some good preservative is necessary with products of this kind. The gelatine or glue must be steeped in water for about twenty-four hours before it is ready to be dissolved by heating. The proper concentration depends upon the jelly strength of the material and the kind of sizing to be done. Mixtures of gelatine, dextrine and soluble starch have been put on the market.

Raygomm.

Raygomm is a standardized product made in various types suitable for the different grades of rayon as well as for the varying methods used in the sizing operation. It is a neutral pure white powder, prepared easily with only fifteen minutes' boiling. The clear solution will remain fluid at room temperature for several days and may be used hot or cold. Raygomm leaves an even, transparent, flexible film of size on the fiber. Yarns thus sized with raygomm are free from harshness, smooth and of improved tensile strength. Colors retain their brilliancy and the natural luster of the yarn remains unaffected. Desizing can be done by any of the usual processes.

The amount of raygomm used varies from 4 to 8 ounces of raygomm to a gallon of water, according to the method of sizing, construction of cloth and denier of the yarn.

President Killheffer—We will now go on to the next paper, Mr. Hughes L. Siever's paper on "Oiled Cotton and the Theory of Chemistry Involved."

. . . Mr. Siever read his paper as follows:

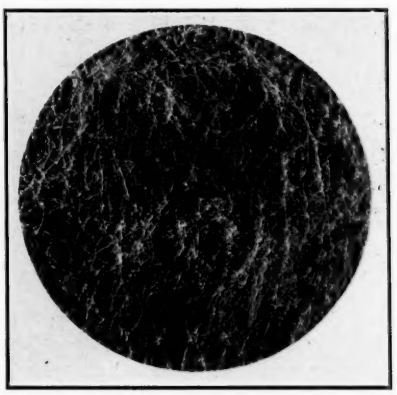
Oiled Cotton and the Chemistry Involved

By Hughes L. Siever

THE application of a lubricant to textile fibers, especially as it applies to cotton, is a comparatively new art in textile manufacturing. While the idea itself is an old one, it has remained for someone to prepare a proper lubricant and to perfect a mechanical means of application. After six years of study and practical experience, the process has reached a degree of efficiency that places the practice of oil-spraying cotton beyond an experiment. It is now operated on a successful basis and applied economically to the entire industry, where fibers of all kinds are manufactured into yarns, such as cotton, wool, jute, asbestos, etc.

The primary object to accomplish by oiling cotton is to relieve the friction between the fibers and materials they come in contact with through the machining processes, and on this principle the application of lubrication has been worked out.

From the time a bale of cotton is opened until it is cleaned, carded and finally spun into yarn there is friction, which in turn releases more or less static electricity. The ever-changing climatic conditions, ar-



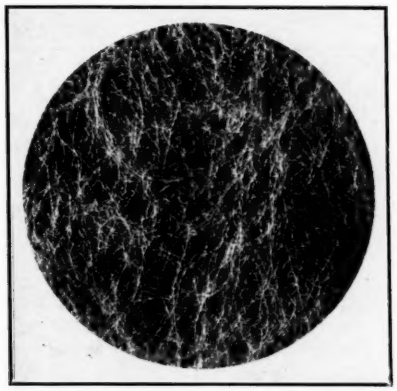
No. 1—Microphotograph shows view comparative to No. 2 of the same cotton, treated with oil, modified at 20 diameters

tificial humidity, the nature of the fibers themselves, etc., all affect cotton manufacturing and at certain times present some difficult problems to the mill.

The claims made for this process are several, among which it might be mentioned—

The cotton cleans better. (Results of North Carolina State College tests on picker.)
Cards better. (Results of North Carolina State College tests on cards.)
With a better web.
Roving is smoother. (Photo of roving or chart showing weight.)
Yarns are more even. (Photo of yarn with less thin places.)
Less fire hazard.
Less invisible waste.
Better visible waste.
Increased elasticity.
Fifty to seventy per cent reduction of dust and fly through the mill.

To substantiate these claims, there are more than two hundred cotton mills using the process to date. Between fifty and sixty new mills have been equipped this year. These mills represent the industry in nearly every line of manufacture. From this fact, and the length of time these mills have been spraying oil, it is quite evident that oiling cotton offers possibilities to



No. 2—Microphotograph shows view comparative to No. 1 of the same cotton, sprayed with 1 per cent Breton Minerol E, modified at 20 diameters.

all cotton manufacturing regardless of staple, its length or its origin.

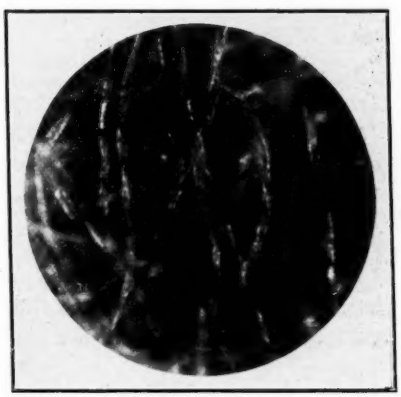
It is not the purpose of this paper to stress its accomplishments in the cotton mill, but to mention something about the chemistry involved. From the foregoing observations it is evident that certain chemical activity is necessary in a lubricant to meet the various conditions in cotton manufacturing. It is also apparent that any oil or grade of oil will not be suitable for this purpose. For instance, the oil must have no action on the fibers; must not tenter or lessen their strength. The card clothing in a cotton mill is perhaps one of the most expensive replacement items. To protect this cloth over a long period of time, the manufacturer of a lubricant for spraying cotton must be certain it will not deteriorate the cloth. The same thing is true of leather rolls, cork rolls, etc. In fact, the mills must be assured of immunity from any ill-effects. It is of more importance that subsequent operations to which the manufactured products may be subjected, such as dyeing, bleaching, mercerizing, scouring, weaving, sizing, etc., shall not be impeded. Therefore, the continuous use of a lubricant for oiling cotton requires qualities not possessed by any ordinary oil.

It would be out of place here to divulge any methods of manufacturing this lubricant. It is sufficient to state there is such a material and that its continuous use in the mills for nearly five years demonstrates the original claims made by the manufacturers, that they have met these various conditions and proven its merits.

In textile practice the vogue of emulsifiable oils has come into general use during the past few years. These products have distinguished themselves by replacing saponifiable oils, to a great extent. The emulsified petroleum oils are used in starch combinations for finishing piece goods, knit goods, in sizing cotton warps, replacing tallow and other animal and vegetable oils.

Large quantities of emulsified petroleum oils are used by themselves as a finish for mercerized cotton yarns. For this purpose these oils have the distinction of adding luster and lubrication. This type of oil is used as a base in combination with certain emulsifying agents soluble in the oil. At this point the writer suggests not to confuse this cotton lubricant with an ordinary emulsifying oil. These are many and are commonly known as soluble oil or self-emulsifying oils. Any mineral oil to which is added a fair amount of saponifiable oil high in free fatty acid content or a free fatty acid, such as red oil, will readily emulsify with alkali. Additions of alcohol, in many cases, increases the solubility of soaps used for making emulsifying oils. The saponification of castor and other fat oils also give products that aid to emulsify other fixed oils. These soluble oils or this type oil, however, is not suitable for spraying cotton fibers.

A lubricant for spraying fibers to be suitable must be in the finest possible state of division and possess

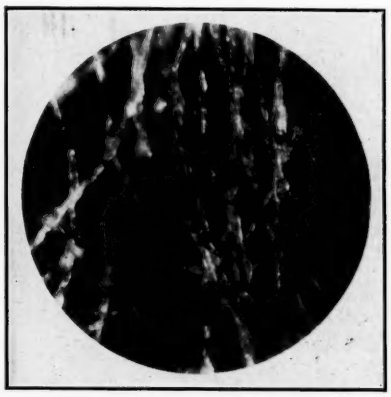


No. 3—Microphotograph taken at 163 diameters shows relative condition of individual fiber.

low surface tension in order to hold the oil on the surface of the fibers rather than allow penetration. This point is to afford the greatest possible lubrication with the minimum amount of oil, because the amount permissible for spraying cotton is about 4 to 6 ounces

to each 100 pounds of stock. This amount of oil must be distributed evenly throughout the mass of fibers. To accomplish this, the lubricant is sprayed under high air pressure, practically converting it into an atmosphere of oil. The point of application usually takes place in the suction or conveying system, the drafts of air forcing the oil through the fibers. The relative influence of oil and emulsifier, with reference to their dispersion while in suspension, must be so minutely incorporated that no separation occurs.

To effect such a combination of oil and emulsifier requires colloid mills, and while this method is used in preparing the lubricant it is also maintained in actual operation at the cotton mill, inasmuch as the mechanical device used to meter the quantity of oil is practically a colloid mill within itself. The oil is being ground all the time spraying is going on, which means the globules are being mechanically reduced



No. 4—Same as No. 3. Note—Those dyed with Breton Mineral E are much clearer, more closely parallel, and have full spiral development.

at all times. This maintains a very finely divided state of suspension of oil and emulsifier.

A mechanical means of dispersion in the manufacture of the lubricant and while being sprayed on to the fibers does not present a difficult problem; the most important is first refining the petroleum—removing certain hydrocarbons—thus preparing the oil to a state of receiving a typical individual emulsifier that is rarely used or mentioned in chemistry.

During the five years of its use in spraying cotton there have been many tests on various products manufactured from oiled cotton. These have been submitted to dyers, bleachers and finishers. No complaint has ever been received where fault could be traced to the use of the oil-spraying process.

It is common knowledge that most any kind of oil will soften the natural coatings on cotton fibers. In fact, various combinations of oils are used to-day in kiers and other boiling-out processes for the purpose of loosening or softening these coatings, thus presenting them to the action of the alkali at an earlier period of the boil in order to reduce the time and improve the boil-out.

When the oil is sprayed on the raw cotton before manufactured it has had more time to react. Experiments show this to be the case and the results are better. After all, dyeing is very much a mechanical process. It is a problem of forcing by pressure or heat or in some way inducing the suspended dyestuffs into the fiber, therefore anything that will lessen the resistance should aid dyeing operations. That is actually what takes place. The oil is freed from the fibers when introduced into the dye bath or into the boil-out, as the case may be. It might be mentioned here that practically all the oil is lost in lubrication through the cotton mill, very little of it remaining on the finished goods.

In other words, its usefulness has been accomplished before the cotton is spun into yarn. This feature of oil-sprayed cotton has been so marked in certain products that it has convinced the manufacturers of greater possibilities by applying the oil just after the cotton is picked or at the gin. This will enable the oil to thoroughly permeate the bale of cotton long before it reaches the cotton mills, thus further increasing its value to the mills, the dyer and the finisher.

The object of this article (fastness to dyeing) is not to emphasize or illustrate by chemical formulae or reactions, but to point out that chemistry plays an important part in this new field of lubrication. An old idea has been solved and made practical by an understanding of chemical problems. Fifty years ago a chemist was a chemist, but to-day he occupies but a small portion of the field. He is almost obliged to be a specialist in some chosen branch of the science. The chemists of twenty years ago could not conceive the idea of converting petroleum into so many different, useful purposes. To the layman this problem appears to be a simple question of oil, but without chemical knowledge he would soon experience serious difficulties.

Mr. Siever—We have here various samples mentioned throughout the article and photographs, microphotographs and some yarn which I will be glad to pass around.

President Killheffer—Are there any questions any member wants to ask in reference to this paper?

Mr. Siever—Those are yarns spun in North Carolina. These are microphotographs and cuts.

President Killheffer—If there is no further discussion on this paper, we will proceed at this time to the business meeting of the Association.

At eleven o'clock there was a paper scheduled by Dr. Krais. He didn't intend to present that personally. He sent it to me and through someone's oversight, they didn't put it with my papers when I left my office, so the paper up until this morning was still reposing peacefully there, but we have telephoned over to have a messenger bring it and it is on the way, so that the paper will have to be presented at the afternoon session.

. . . The meeting adjourned at eleven-thirty o'clock.

SATURDAY AFTERNOON SESSION

December 7, 1929

THE meeting convened at two-thirty o'clock with Walter S. Williams, Vice-President, presiding.

Chairman Williams—I think Mr. Wood is supposed to preside at this meeting, but I don't seem to find him. I think that we had better start the meeting, and if he comes in I shall be very glad to hand it over to him.

[The first paper of the afternoon was by Dr George L. Clark, who spoke on "The Present Status and Future Possibilities of X-ray Research on Textiles." Insomuch as this paper was delivered extempore and hence requires appreciable editing by Mr. Clark, it was thought wise to include this in an early issue of the AMERICAN DYESTUFF REPORTER.—EDITOR.]

Chairman Williams—The next subject is "Dyeing and Finishing Celanese Fabrics," by Herbert Platt.

. . . Mr. Platt presented his paper as follows:

Dyeing and Finishing Celanese Fabrics

By HERBERT PLATT
Superintendent Dyeing Department, Celanese Corporation of America

THERE are but four natural products which have proved capable of being worked up into fabrics which have withstood the test of experience as basic materials for clothing civilized men. Two of them, silk and wool, are of animal origin, and the other two, flax and cotton, are derived from the vegetable kingdom.

It was not until the beginning of the present century that any degree of success attended human efforts to produce a synthetic fiber. The three main processes developed at that time gave a product which was substantially the same as a hydrated form of regenerated cellulose. It was found that the regenerated cellulose was susceptible to water and considerably weaker when wet. Much research energy has been devoted to saving sufficient of the original strength to make material strong enough for textile purposes and the development of the present regenerated cellulose rayon industries.

CELANESE PRODUCED

A more recent development in the production of a synthetic fiber is the use of cellulose acetate, which was found to possess the essential properties desirable in a textile fiber. It was using cellulose acetate that the Celanese companies after the World War developed commercially the manufacture of Celanese, a textile fiber which has been on the market for some time, and no doubt its properties and advantages are well known to the majority of you present.

EARLY DYEING TROUBLES

Perhaps one of the most interesting phases of Celanese has been the development of dyestuffs and methods of successful coloration for the Celanese yarns and fabrics to give shades which meet the demands of fastness to light and washing.

During the early history of the dyeing of Celanese, *basic colors* failed because of looseness to washing and alkalies and mostly all were loose to light; *acid colors* were discarded because of frequent looseness to acid and alkalies and immiscibility with basic colors for compound shades. The *ingrain* or development method using simple bases was not entirely satisfactory for general use because of limitation in shades obtainable and on account of the difficulty in matching.

DEVELOPMENT OF SRA DYES

The necessity for a special range of dyestuffs was thus indicated. The problem was attacked by the British Celanese, and after much research the range of SRA dyestuffs was evolved. The feature about the SRA dyestuffs is that they are not only a range of dyestuffs specially for dyeing Celanese but also the level dyeing and general high standard of light and washing fastness of the resulting shades.

The SRA dyestuffs will dye Celanese from soft water containing a little soap; they leave cotton and regenerated cellulose rayon white; they do not dye silk or wool, although these fibers are slightly stained. All shades are dyed direct except black, which is diazotized and developed.

CROSS-DYEING

In conjunction with cotton dyes and acid dyes which leave Celanese white, or are Celanese-resist, the SRA

dyes open up endless possibilities for dyeing bright and contrasting two-color effects in one bath on fabrics made of Celanese, along with cotton, rayon, silk or wool.

Textiles Made from Celanese Treated by the Dyer, Etc.

To-day the dyer and the finisher process Celanese from the knitting, weaving and hosiery trade as all-Celanese goods and as mixtures with other fibers. We find Celanese knitted into Milanese, tricot, plain and fancy circular fabrics. We find these made up into dress goods of fine draping quality, underwear which is comfortable, washes and wears well, and bathing suits which withstand the sea water.

Goods woven of 100% Celanese are the closest approach to real silk yet achieved; they comprise taffetas, crepes, satins, failles, twills, voiles, etc., which we find used variously in the dress goods, underwear, drapery or lining trade. Stockings of Celanese are on the market, and Celanese is used extensively in fancy hose where two or three color effects are achieved by cross-dyeing. Many beautiful fabrics are made of real silk and Celanese, the Celanese imparting regularity to the goods.

Mixed fabrics of Celanese with cotton, rayon or wool of varied constructions are processed by the dyer to solid shades and two-tone effects.

General Properties of Celanese to Be Noted by Dyer

The dyeing and finishing is an important link in the chain of operations from fiber to finished fabric. The properties of the fiber in the fabric govern largely how the fabric is to be dyed and processed to achieve the desired results. It is therefore important to consider briefly the properties of Celanese.

Water only slowly wets out the Celanese filaments, the time of wetting out being largely dependent on temperature. Boiling water, or water above 90° C., and wet steam diminish the luster of the yarn or fabric. Dry steam does not affect the luster of Celanese, although very high-pressure steam will cause it to harden and become brittle. Pressure in the presence of moisture and heat will tend to cause glazing and brittleness under extreme conditions. Celanese has low retention powers for water and is thus easily dried. The chemical properties of Celanese are slightly acidic compared to cellulose; it is therefore susceptible to strong alkalies. It is not, however, affected by acids such as are used in dye baths and finishes. Bleaching with sodium hypochlorite or hydrogen peroxide may be used on fabrics containing Celanese.

General Method of Scouring, Bleachiing and Dyeing

Before dyeing Celanese goods, a scouring treatment is given to remove the small amount of lubricating oil and prepare the goods for the dyeing. A thorough scouring is recommended, as the time is more than saved in the subsequent dyeing operation. A safe or useful scour would consist of 1 to 2 grams per liter olive oil soap, or some good alkali-free soap, and 1 to 3 c.c. per liter ammonia, treating at 75° C. for three-quarters of an hour.

It will be found that the addition of 2 to 5 c.c. per liter Celascour can be used with advantage in the scouring bath. Celascour is a valuable scouring agent for use on Celanese products; it was devised and manufactured because most of the scouring agents on the market are primarily for cotton or other textile fibers. While many of these are harmless when applied to Celanese, serious losses have occurred through an unfortunate choice of a scouring agent unsuitable for Celanese. Celascour may be used on Celanese or any other fiber with absolute safety.

The bleaching of Celanese is best accomplished using ¼° Tw. sodium hypochlorite either neutralized or made slightly acid with acetic acid. A quicker method is to bleach in the scouring bath, if it is not too dirty, or in a subsequent soap bath. A good grade of sodium hypochlorite should be obtained for this method, and it is recommended that 50° Tw. sodium hypochlorite of not more than 3% alkalinity be used. When bleaching in a soap or scour bath add 3 c.c. per liter 50° Tw. sodium hypochlorite and treat the goods at 60° C. for three-quarters to one hour. After bleaching, the goods are well washed off. If an acid bleach has been used the goods are given an antichlor of 1 gram per liter sodium bisulphite cold for ten minutes.

Dyeing

Celanese is dyed with SRA dyestuffs, which are level-dyeing and of good fastness to light, washing, perspiration and other agencies. The dyestuffs are best dissolved by pouring hot soapy water onto the paste or powder with vigorous stirring. The composition of the dye bath and the assistants used are dependent on the type of goods and dyeing machine. The best assistants for SRA colors are soap, Turkey Red oil and Celascour. A typical dye bath would contain ¼ to 1 gram per liter soap and 1 to 5 c.c. Turkey Red oil or Celascour.

It will be found that Celascour is advantageous in wetting out and penetrating material which is closely woven or contains high-twist yarn. The assistants are added to the dye bath before the color is partly

used for dissolving the dyestuffs. Where soft water is not available an addition of ½ c.c. per liter ammonia or 0.1 to 0.15 gram per liter soda ash may be made to the dye bath.

The dyeing is usually carried out at 80° C. throughout.

Dyehouse Manipulation of Various Forms of Celanese

The machines used for the dyehouse manipulation of Celanese in its various forms are mostly those used in regular dyeing practice; Monel-metal-lined machines are ideal and wood is satisfactory on all shades. Copper linings are used for all shades except bleaching and blacks.

Yarn—Yarn is dyed in skeins by hand or by machine using the typical recipe previously indicated. Where the yarn is dyed by hand, the two-stick method is preferred, using the sticks to turn the hanks. After dyeing, the yarn is given a finish of olive oil emulsion.

Circular Knit Fabric—Circular knitted fabric is dyed on the winch or reel machine and is given a thorough scouring before dyeing, as unequal scouring gives uneven dyeing. The scouring and dyeing are conducted at 70 to 80° C. throughout. If the scour bath is not too dirty it is used for the dyeing with SRA dyes. After dyeing, the goods are given an olive oil emulsion finish to insure proper working in stitching or making up.

Flat Knit Fabric—Flat knit or warp knit goods are prepared for dyeing on the reel by tacking at intervals or completely sewing together the edges of the fabric. The degree of preparation is dependent on the knit and the curling of the edges. Pieces of equal length are made into rope form, and generally it is preferable to have 40 to 60 yard pieces, as shorter lengths tend to crease. The best results are obtained with a moderately loaded machine, avoiding overloading. The flat knit goods require one hour good scouring at 75 to 80° C. After dyeing, the goods are rinsed in warm water and given an olive oil emulsion finish. After a light extracting they are finished on the stationary frame, or on the moving tenter when the knit is such that the finished dimensions can be controlled on the moving machine.

Woven Fabric 100% Celanese—Goods woven of 100% Celanese are dyed where possible on the jig, thus keeping fabrics such as taffetas, satins, twills, etc., open width and free from creases from the loom to the finished goods. Many fabrics are with advantage padded with Celascour or with hot Turkey Red oil as a preliminary process. This swells the fabric and makes it firmer; it also helps in the scouring and dyeing process. The Celascour is used in this case without dilution and is best applied in the pad mangle at 75° C., so that the fabric contains 50 to 80% its weight of Celascour. After padding, the fabric is batched and allowed to stand several hours, most conveniently overnight.

(*a*) *Jigs*—The dye jigs used are the standard makes of light running jigs, with ball or roller bearing on the auxiliary rolls, to reduce the tension on the fabric and avoid stretching. The fabric with or without the preliminary padding is run on the jig and given one or two ends in cold water and two ends in warm water to remove the gelatine size, along with any tinting material. This bath is then dropped and a scour bath made up with ½ to 1 gram per liter soap, 5 to 10 c.c. per liter Turkey Red oil or Celascour, and, according to the hardness of the water, 0.05 to 0.20 gram per liter soda ash. The goods are then scoured, depending on the cleanliness and the yardage of the batch for four ends at 60° C.

The SRA dyestuffs are then carefully dissolved, using soap, Turkey Red oil or Celascour, and, after sieving, the dyestuff solution is added to the bath at two or four ends and the dyeing conducted at 60° C., and then up to 75 to 80° C., according to shade. After dyeing, the fabric is given a warm and a cold rinse. The jig-dyed fabric is then hydroextracted on the type of extractor which rotates the batch on the batch roller at a high speed. The goods are then ready to dry and finish.

(*b*) *Open Tanks*—Light-weight fabrics, such as voiles and ninons, may be dyed in large open tanks or in boil-off tubs. The plaited goods are suspended, by means of strings attached to one selvedge, in the usual soap, scouring and dyeing bath. This method will be found suitable for batches of 1,500 to 4,000 yards. The voile or ninon after dyeing is basket-extracted, the pieces sewed together, when they are ready to dry and finish. Small batches of voile or similar fabrics are plaited and scoured in open tanks suspended on strings in 5 to 10 grams per liter soap for one to three hours at 80° C., and then dyed on the reel.

(*c*) *Star Machines*—Celanese fabrics such as velvets and some of the crepe fabrics are dyed on frames or star machines of the vertical or horizontal type and hydroextracted on the vacuum extractor.

Reels or Winches—Fabrics of Celanese crepe may be dyed on the reel. It is necessary, however, that they be thoroughly wet out before they are put on the reel machine, to avoid creasing. The wetting out is usually done by suspending the plaited fabric on strings or in hank form in large open tanks containing 10 grams per liter soap at 80° C., treating for two to four hours, depending on the fabric. Where it is desirable to give the fabric a subdued luster or a com-

plete deluster, advantage is taken of the special property of Celanese and the goods subjected to the required temperature during the wetting-out process in the open tanks. A temperature of 90 to 92° C. gives a subdued luster and 98° C. a deluster. After thorough wetting out, the goods are loaded on the reel machine and dyed from the usual SRA dye bath. After hydroextracting on the vacuum or suction extractor they are ready for drying and finishing.

Drying and Finishing

Generally, woven fabrics of 100% Celanese are dried on the tenter and require little more than the simple tentering, along with a slight calendering, rotary pressing or breaking where necessary. Many of the light-weight fabrics may be dried and finished on the Palmer. On Celanese crepe fabrics the short loop or crepe net drier may be used. Drying of "all-Celanese" woven fabrics on the drying cans requires careful adjustment of the temperature and running of the cans. Hot drying cans have a tendency to give a glazed appearance which is not removed except by reprocessing. Can-dried Celanese fabrics usually require heavier finishing treatments.

Treatment of Mixed Fabrics

When processing fabrics made from Celanese and other fibers the dyer will consider the individual properties of each fiber.

Cotton-Celanese—Kier boils would not be given on fabrics containing Celanese. The manufacturer using Celanese frequently uses bleached cotton when making mixed fabrics. Celanese is quite as resistant as other textile fibers to the action of diastase, hypochlorite and peroxide, so that the customary operations with diastase ferments, bleaching with sodium or calcium hypochlorite or peroxide of hydrogen, respectively, may be carried out on goods containing Celanese.

Mixed goods of cotton and Celanese present an opportunity for producing cross-dye or bicolor effects in the dyeing process. The manipulation in the dyehouse consists of treatment with some diastase preparation to remove any starch used in sizing, followed by a scour which will usually consist of 2 grams per liter soap, 3 c.c. per liter ammonia (or 2% soda ash on weight of goods) and 3 to 5 c.c. per liter Celascour at 80° C.

Bleaching of Celanese and cotton goods may be carried out in exactly the same manner as for chemicking cotton.

SRA's and Direct Cotton Dyes

The simplest method of dyeing Celanese-cotton mixtures is to use C. R. (Celanese resist) direct cotton dyes in the same bath with SRA dyes. By this method either solid shades or contrasting bi-color effects may be obtained. The best results are achieved dyeing at 85° C. throughout and where necessary adding 10 to 20% Glauber salt to exhaust the direct cotton dyestuffs. A long list of direct cotton dyestuffs which leave Celanese white will be found in Dyeing Leaflet No. 2 (issued by the Celanese Corporation) and a large number of direct cotton dyes are put out by the makers as "Celanese Resist" or Celanese White. The SRA dyes do not dye cotton and the Celanese may be dyed leaving the cotton white. The best method is to dye in a bath containing ¼ to 1 gram per liter soap and 1 to 5 c.c. per liter Celascour or Turkey Red oil, entering the goods at 85° C. and dyeing at 85° C. throughout.

The SRA dyestuff is best fed on in portions, avoiding overloading the bath with dyestuff. Where the cotton is stained from excess SRA dyestuff it is cleared by a light soap, and where necessary ¼ gram per liter sodium hydrosulphite in the soap.

SRA's and Sulphur Dyes

The SRA dyestuffs are of good fastness to washing, and where it is desired to have a higher degree of washing fastness on Celanese-cotton goods than is obtained with direct cotton dyes, the cotton may be dyed with sulphur dyestuffs. It has been found that a large number of sulphur colors are capable of being dyed on cotton and leaving the Celanese white. The normal method of application of the sulphur dyestuffs on cotton is, however, modified, because the usual quantities of sodium sulphide added when dyeing cotton give an alkali concentration which is sufficient to cause partial saponification of the Celanese and therefore staining with the sulphur dyestuff. When dyeing the cotton with sulphur colors so as to leave the Celanese white the following dye bath is used: Three parts "Celanese White" sulphur dyestuff (100% powder), 2 parts rock sodium sulphite (or 4 parts crystals), 2 parts sodium hydrosulphite, 1 to 10 c.c. per liter Celascour.

To dissolve the dyestuffs it is wet with Celascour, diluted with water, and the sodium sulphite added, the temperature is then raised to 90° C. when the sulphide dissolves; the sodium hydrosulphite is dredged in and the solution stirred. The solution is added to the dye bath which has been heated to 50° C. and contains the remainder of the Celascour. The goods are entered in the dye bath at 50° C. and the temperature raised to 75° C., dyeing one hour or to shade. If required, additions to hydrosulphite or Celascour are made, but no further sodium sulphite is added. After dyeing, rinse the goods in hot water and scour in 2.5 grams per liter soap at 60° C. The amount of Celascour in the dye bath varies with individual dyestuffs, 1 to 2 c.c. per liter is usually

sufficient; only on blacks and heavy shades is 8 to 10 c.c. per liter used.

Where the cotton is dyed with sulphur dyestuffs and it is desired to dye the Celanese, it is dyed in a fresh soap bath, using those SRA dyes particularly recommended for washing fastness.

SRA and Vat Dyes

Where it is desirable to have dyeings which are very fast to light on cotton-Celanese fabrics, the British Celanese evolved a method whereby many vat dyes may be dyed on cotton without saponifying and dyeing the Celanese. They found that by using the sodium salts of phenols, cresols or naphthols, alkalinity sufficient for solution of the leuco compounds of the vat dyes was obtained, with very little tendency to saponify the Celanese. Sodium phenolate was found to be best for general use and incidently most economical. The method is described in Dyeing Leaflet No. 5 (issued by the Celanese Corporation) which also contains a list of some of the vat dyes suitable. The method, briefly, is as follows: Make a stock vat using one kilo vat dyestuff powder, and wet with Celascour or Turkey Red oil, add 100 liters hot water and 30 kilo. sodium phenolate; dredge in 3 kilo. sodium hydrosulphite with stirring until reduced and completely in solution.

The dye bath is set with an amount of sodium phenolate, calculated with that from the stock vat will give a bath of 15 grams per liter sodium phenolate, 0.35 grams per liter glue and 0.15 grams per liter sodium hydrosulphite. In many instances the vat dyestuff may be set in the dye bath. The dyeing temperature as a rule is 40° to 45° C., but varies with individual dyestuffs. After dyeing the goods are squeezed, oxidized and rinsed, and if the Celanese is to be left white, given a soaping at 60° C. in 1 to 2 grams per liter soap. Where the Celanese is to be dyed, the SRA* (starred) colors are dyed from the after-soaping bath. The SRA* dyestuffs are particularly used where very fast to light dyeings are required on Celanese.

The method of dyeing the vat dyestuffs with reduced alkalinity using the sodium phenolate will be found useful on wool or real silk. The Solanthrenes and the Indigosols will also be found of interest when dyeing the cotton fast to light in Celanese-cotton goods, some of these dyes stain the Celanese, but with further developments of the water soluble leuco compounds they may prove useful.

Celanese and Silk

Many beautiful fabrics are made of Celanese and real silk. In some of these fabrics the Celanese is finished in its natural luster and in others a diminished luster or a deluster is given. It is in the degumming of the real silk that the temperature is controlled so as to maintain or diminish the luster. Where the luster is maintained the temperature is restricted to 80 or 85° C. The degumming is best controlled by the pH value, a typical bath would be 10 to 20 grams per liter soap; at 85° C., maintained at a pH of 10.5 by additions of sodium phenolate, borax or careful additions of caustic soda. The degumming will require 2 to 5 hours, depending on the fabric.

Where a diminished luster is required a temperature of 92° C. is maintained. For a full deluster a temperature of 98° C. and a pH value of 10.0. The manipulation of the fabric is the same as when degumming real silk fabric, treating the goods either plaited or hanked in boil-off tanks.

Celanese-real silk fabrics may be bleached with the usual hydrogen peroxide bleach.

The dyeing of the fabric may be achieved from a soap bath using SRA dyes and direct cotton dyes in the same bath, when either solid shades or two-color effects may be obtained. Where it is desired to use acid dyestuffs on the silk, those acid dyestuffs which leave Celanese white should be selected. It will be found that acid dyes may be used in the same bath with the SRA dye powders, dyeing from a slightly acid bath, using S. N. R. A. as an assistant instead of soap, Celascour or Turkey Red oil.

Black may be dyed on silk and Celanese mixtures by dyeing with SRA Black IV and Chlorazol Black LF, then diazotizing and developing with beta-oxy-naphthoic acid. The following method, although not so fast to light as SRA Black IV, is also satisfactory: Dye with 2% Dianisidine and an acid black (Spuramine Black BR) from 1 c.c. per liter formic acid bath, then diazotize and develop with beta-oxy-naphthoic acid.

Celanese and Wool

Celanese when used with wool imparts a sparkle to the fabric and gives a pleasing appearance not obtainable by wool alone, still retaining the softness of the wool.

Woolen—Woolen goods containing Celanese are best scoured with olive oil soap and ammonia at 75 to 80° C.; the bleaching is best accomplished with hydrogen peroxide. The dyeing is usually done in two baths, first dyeing the Celanese with SRA colors and then dyeing the wool with acid dyestuffs, selected from the large number which leave Celanese white. Where the acid dyestuff does not readily level out, 10 grams per liter ammonium sulphate added to the bath will protect the Celanese when dyed at the boil to level out the acid dyestuff.

Worsteds—On worsted goods containing Celanese the

crabbing and wet steaming, through which the majority of worsteds pass, is a problem not entirely solved. The addition of salts to the water in the crab will be of advantage in retaining the luster of the Celanese. In the steaming process padding the goods with a concentrated solution of salts before blowing with steam may prove helpful.

Printing

Probably there is no branch of the art of coloring Celanese, where most recent developments have taken place, than in the process of printing. Chemically the printing of Celanese presents no difficulty. Special appliances are not required, other than occasional modifications of those in general use. The physical properties of the Celanese are possibly the most important factors, and it is well to keep in mind its resistance to water and its behavior with wet and dry steam.

Direct Styles—Direct styles have been printed extensively with vat dyestuffs, thus meeting the highest demands of fastness for wash goods and draperies.

Vat Dyes—The Anthraquinone vat dyes do not generally fix on unchanged Celanese, and satisfactory fixation depends on partial conversion of the printed portions to cellulose. If this hydrolysis is insufficient the color will not be of maximum fastness to washing, rubbing and marking off.

Indigoid vat dyestuffs fix directly on Celanese without saponification, in many instances, however, a trace of saponification improves the rubbing. The vat printing pastes correspond closely to regular practice, the potassium carbonate method is preferred with small additions of caustic soda as are necessary. Drying in cool towers is preferable. Aging at 214° F. will be found satisfactory.

The safest and most generally applicable penetrating agent on Celanese is ethyl alcohol. Gylcerine is a useful addition. In some instances ethylene glycol and di-ethylene glycol will be found to be advantageous, but care should be taken when using some of the ethers of the above compounds not to use excess. Small additions of phenol or resorcinol act as penetrating agents, phenol requires rigid control as the slightest excess on the good gives tendering.

Basics—Where direct prints of extreme brightness rather than fastness are required, basic colors may be used. The basic colors fix directly on Celanese without recourse to tannic acid, and the shades are much brighter than with tannic acid. The simplest paste would consist of dyestuff and thickening along with acetic acid and ethyl alcohol. Prolonged aging or steaming under slight pressure is desirable.

SRA—Where prints of good brightness covering power and fastness are required, the Celanese may be printed with direct dyeing dyestuffs such as the SRA colors. The printing paste will consist of British gum or gum arabic thickening, along with ammonia, and ethyl alcohol or other penetrating agents. The print will require a prolonged aging or better slight pressure steaming at 3 to 5 pounds. It has been found that better and more economical results are achieved by milling when making up the printing paste. Padding the goods with 3° Tw. aluminum acetate and drying before printing, gives clearness to the edges of the print. This method is particularly good for large blotch prints.

Oxidation Blacks—The best blacks are printed on Celanese by the oxidation method, both Diphenyl Aniline and Aniline Black are largely used—ethyl alcohol is applicable as a penetrating agent. Resist prints may be made with oxidation black, the resist is essentially sodium oxalate or caustic soda or hydrosulphite. It is interesting to note SRA colors may be added to a sodium oxalate resist.

Discharge Style—Many of the dyestuffs for dyeing Celanese are dischargeable, the following SRA dyes are dischargeable to white:

SRA Pure Yellow III
SRA Golden Yellow XI
SRA Golden Orange I
SRA Golden Orange III
SRA Orange I
SRA Orange III
SRA Red I
SRA Red III
SRA Red V

The SRA Golden Orange I, SRA Red III and SRA Red V are most easily discharged. Where bright dischargeable blues are desired

Setocyanine and Setoglaucine

are of fair fastness and discharge white. For compound shades Cellit Blue R, which discharges to a fair white in medium shades, may be used in the same bath with the SRA dyestuffs by adding Glauber salt for exhausting. A black for discharge work may be obtained using SRA Discharge Black III diazotized and developed with beta-oxy-naphthoic acid. Dischargeable navy blues, blacks and other shades have been obtained by dyeing with not more than 0.3% dianisidine developed with beta-oxy-naphthoic acid and then topped with dischargeable colors such as SRA Red III and SRA Golden Orange I. Dark blues of excellent fastness which are dischargeable may be

obtained dyeing Fast Black LB Base developed with beta-oxy-naphthoic acid.

Where discharge effects are desired on rich full grounds advantage may be taken of the property of Celanese absorbing cheap and simple bases which may be diazotized and developed. Although many of these discharge after development, better results may be obtained by dyeing the base, printing on the discharge, aging and the diazotizing and developing. Typical bases would be:

Para Nitraniline
Paranitroortho Anisidine
Amido azo benzene
Fast Black LB Base
SRA Discharge Base III

The following SRA colors may also be diazotized and developed:

SRA Golden Yellow IX
SRA Orange III
SRA Black IV

The following is a list of developers giving a variety of shades in good all-around fastness:

Naphthol ASG
Phenol
Resorcinol
Diethyl Aniline
Diphenylamine
Beta-naphthol.
Beta-oxy-naphthoic Acid.
Naphthylamine Ether.

For white discharges the best results are obtained using Decroline, also Protoline. A typical white discharge paste contains 18 to 25% Decroline. It has been found that much easier discharging is obtained by milling the Decroline paste in a ball mill, the milled Decroline paste will keep satisfactorily for two or three days if the precaution is taken not to heat the paste after it has been milled. As a penetrating agent ethyl alcohol is most useful, small additions of sodium phenolate are helpful in some instances; glycerine is a useful addition to the paste. Additions of Anthraquinone and zinc oxide are often made. Aging is usually at 214° F., passing the goods through the ager twice.

White discharges may also be obtained with Formopon. We have found that the addition of Anthraquinone assists materially and zinc oxide is a useful addition. Ethyl alcohol, also diethylene glycol, are helpful as penetrating agents, and in some instances small amounts of sodium phenolate. With Formopon discharges the printer will find it necessary to determine the most satisfactory time of aging, generally more than one passage will be required. Too much moisture or steaming causes running, although some moisture is required; 212 to 214° F. will probably be the best temperature. Padding the goods with aluminum acetate before printing gives clearer edges.

For color discharges vat dyes are generally used, except where extreme brightness is required and then basic dyes are used.

Dry Cleaning

Before closing we would make a few remarks about dry cleaning Celanese.

A few years ago Celanese met with considerable antagonism in the dry-cleaning industry. This was entirely due to lack of knowledge of the fabric on the part of the cleaner.

Trouble occurred in the spotting rooms, due to the use of agents, such as chloroform, acetone, lysol, which are injurious to Celanese. Through the splendid cooperation of the National Association of Dyers and Cleaners in the conduct of an educational campaign, the cleaners were shown how to identify Celanese and avoid injurious chemicals in the spotting, and use such safe agents as ethyl alcohol, carbon tetrachloride, benzene, glycerine, etc. To-day we find the dry cleaners throughout the country gladly process Celanese, and many admit it cleans easier than other fabrics.

Chairman Williams—Are there any questions or discussions on this paper?

Our next paper is by Mrs. Margaret Hayden Rorke, who will talk on "Fashion and the Chemist." Mrs. Rorke is the managing director of the Textile Color Card Association of the United States. Mrs. Rorke! (Applause.) . . . Mrs. Rorke read her paper as follows:

Fashion and the Chemist

By Margaret Hayden Rorke
Managing Director, the Textile Color Card Association of the United States, Inc.

OTHERS may call you chemists and colorists, but I shall address you to-day as alchemists or transmitters of the rainbow into that noblest element of industrial art—Color. Perhaps I should also call you necromancers, for according to the ancients a necromancer was a dealer in magic, and it is to you that industry and fashion look for the magic of color. And what a magic word that is—COLOR! To me it expresses the tempo of our age—the pulse beat of our in-

dustrial life—the argot of our time, the rhythmic counterpoint of the textile art.

Though the traditional first raiment of Eve and Adam was green—and in the parlance of modern color nomenclature a leafy green—it was the only time in the history of fashion that the chemist or colorist "had nothing to do with the case."

The greatest influence in the advancement of the textile art through all its epochs has been that elusive thing called fashion, and in its dramatic evolution the chemist and colorist have played a leading role. Color is synonymous with fashion, and fashion is powerless to express herself colorfully without the chemist. The story of color is the story of the human race. A piece of colored cloth is but the mute witness of man's long journey from savagery to civilization. I can never look at or touch a bit of dyed fabric without recalling the romance and beauty of heritage that lingers in each of its colored strands. A modern multi-hued print is, to me, a mirror, reflecting the history, the symbolism, the tradition of color; for, after all, the part played by the symbolism of color in man's life is reflected in his arts and crafts.

I recall how the late Dr. Stewart Culin, famous curator of ethnology at the Brooklyn Museum, once told me that it was when belief in magic was widespread that the significance of color was established with fundamental associations which are the heritage of to-day. The use of red as a predominating color of many ancient peoples was not the reflection of a crude taste but the belief in its magic power. Yellow, color of the metal gold, was reserved by the ancient Japanese for the exclusive use of the Emperor. Never was the use of color left to caprice or mere chance. Red, with its mystic potency, made necessary the vermilion pencil with which the Emperor signed his documents. A red seal made valid all Imperial decrees. The old lapidary was a dispenser of charms. The blue of the turquoise, the green of the jade, were priceless because their color was the hue associated with immortality, with verdure, with life, with spiritual rebirth. The little blue and green faïence amulets and the images the Egyptians placed close to their dead, bear witness of the prowess of these lovely hues. The sacred magic colors of most of our Indian tribes were yellow, blue, red, white and black, all of which have colored their many crafts.

With the advent of christianity color assumed a new significance. Red became the symbol of fortitude; green the expression of hope; purple the penitential color; white and blue the symbols of purity, glory and innocence. Yellow denoted treachery and weakness, while black, the epitome of profound sorrow, death. Thus, just as man's habits, his thoughts, his life itself were influenced by color, so he in turn transmitted this influence into his industrial arts.

The dyeing of textiles was of great importance to the ancients. Although their palette was very limited, the purity of their colors gave them a rare beauty. Because of its peculiar susceptibility to color, man prized silk above all other textiles, thus creating an industry and establishing a commerce that became one of the great dynamic forces of the world. To trace the history of ancient pigments makes a lovely tale. The purple of the Phoenicians, the saffron of the Egyptians, the indigo and the red of the kermes insect, so priceless and so sought after by India and Persia, were ever the source and depository of the world's color sense and inspiration.

There is a very ancient and beautiful Persian legend that tells of Christ being a dyer and that as an apprentice one day He was instructed to dye some fabrics in different hues. Christ, so the legend runs, placed all of the materials in one vat, and the dyer, when he took them out, found to his great astonishment that each was dyed a different color. Until the seventeenth century in Persia a dyehouse was called Christ's workshop.

But long before silk was discovered the art of dyeing other fibers was being practiced in India and Egypt. Pliny tells of garments being painted by the Egyptians in a most unique manner; the white cloths being smeared, not with colors, but with drugs which absorbed the colors. The application did not show on the cloth until it was immersed in hot dyeing fluid, and when removed, appeared to be painted with several different colors. This process was later termed "Polygenetic color dyeing" and thus illustrates how deeply the Egyptians had delved into the mystery of dyes and their application. Much of their knowledge, however, had been gathered from India, which country may be considered the real birthplace of both dyeing and staining of fabrics.

Although the ancient Greeks derived their culture and civilization from the Egyptians, yet in the art of dyeing they do not seem to have acquired much perfection. At least they did not advance in the same degree as the Romans, who brought the art to a higher standard, and although the Chinese possessed the most perfect medium of color expression—silk—they did not practice dyeing to any great extent until they were taught by the Hindoos and Persians who had attained a very high degree of civilization.

After the fall of the Roman Empire, when all progress in the sciences and arts had ceased, the Moors and Saracens advanced in civilization to a marked degree, and they in turn brought their arts and sciences, such as paper making and the extraction and use of dyes, to a high level. At the time of the Crusades, the Christians brought back from the Holy Land many arts of the East, including dyeing. And so, era after era, mankind has toiled wearily but unceasingly to discover pigments that color might decorate his raiment and domicile. The blue

of the Egyptians, the green of the Romans, the red of the Saracens, the purple of the Phoenicians, and so on down through the ages, race after race have contributed their share to make the heritage of modern dyestuff production.

The beauty of color as portrayed by textiles has grown apace with industrial progress. As silk and other fabrics have passed through their most effective and virile medium of expression, to-day we have the accumulated beauty of the colors of all ages, treasures of heritage from which modern industry gathers inspiration.

History has shown us that all nations, races and peoples have introduced color in their industries, first through the development of their textile arts, and all, no doubt, because of the vanity of woman. Because of her love of raiment, her flare for color and her quest for beauty—woman's vanity has been the greatest stimulus to industry—and should be added to the beatitudes!

But not until the youthful Perkins, like the true alchemist of old, unlocked the secret of coal tar and transmitted it to the gold of color, was the chemist able to give his greatest contribution to industry and fashion. From them came new rendition of color, new interpretations. This transition was slow but fundamental. In spite of the devastating effects of the World War, industry, art and color stand to-day at the gateway to another great Renaissance in the development of which America can justly and proudly claim a very large share. To that splendid army of courageous American chemists and colorists, who against the greatest odds, built in a short twelve years a great industry which produces instead of 10% before the war, over 90% of the dyes used in the United States—the greatest color-consuming nation in the world—all praise is due. And since there is probably no branch of industry which involves the use of a greater variety of chemical reaction than that of the textile industry, to you, our modern necromancers and alchemists, is due great glory for your share in making America one of the greatest textile-producing countries of the world.

All industries to-day are realizing the stimulating power of color and its psychological reaction on the consumer. Color is the most vital factor in the merchandising of any produce. The line of demarcation is well defined, however, between the purely aesthetic and the commercial value. It is because of this aspect, the importance of which is recognized by all industries, that the American producer is recognizing the economic value of color standardization as promoted by the Textile Color Card Association of the United States.

The association is the great color co-ordinator of American industry; the founder of a commercial color language. It is the recognized authority and arbiter of color in fashion. It creates and standardizes through the American color cards, with their world-wide circulation, the colors American industry uses. These cards represent careful research, study and analysis of staple colors, semi-staples and novelty shades such as represent the volume of color consumption and in ranges wide enough to meet all the requirements of industry.

The Textile Color Card Association links the correlated industries together through industrial committees and trade associations so that constructive seasonal color programs can be promoted, color problems between industries adjusted and the economic production of color fostered. Through its influence a great color consciousness has been awakened in the American people. Industries have been brought closer to the arts, and trades have been revitalized.

In the building of the Textile Color Card Association, the American chemist and colorist has contributed great assistance. For while it is the function of the association to standardize commercial colors and to interpret and forecast seasonal color development for the economic aid of industrial production, it is only through the chemist and colorist that the association can vitalize its colors so that industry can interpret them to the consumer. The association cannot pay too high a tribute to the dyestuff industry and members of your profession for the helpful co-operation and support given it. We are proud to have your vice-president, Mr. Wood, a member of our board of directors.

I think you will be interested to know that the association has established three scholarships for the creation of a higher appreciation of color in the student. The schools benefiting are the Philadelphia Textile School, the Lowell Textile School and the New York Textile High School. It is the aim of the association to increase these scholarships in other schools throughout this country and eventually to establish exchange scholarships in some of the leading textile schools in Europe. Industry needs trained colorists and it is the ambition of the association that it may be one of the means of training men and women who will carry the message of color into our industrial arts, to the end that a higher and finer appreciation of color will become the heritage of the American people.

More and more, through the influence of the association's activities, is industry responding to color. Modern life is indeed vibrant with it. In every phase of our social and industrial existence, its prevailing color themes find expression. But with the advent of color into so many diversified industries fashion challenges the chemist. With color's new uses, into the dye bath go many commodities that puritanical whiteness has shrouded for centuries. No longer do we pass our sleeping hours on beds of snowy hue. We dream to the tune of pink,

mauve, green or blue! Lilly white table linen, forced to take a back seat in fashion by the sudden and prolonged vogue for bare tables and lace covers, has staged a comeback only by the help of color and its subtle variations. Bathrooms, once prophylactic in their uninteresting purity, have become colorful and artistic. Tiles, plumbing fixtures, rubber curtains, towels, soaps, bath mats, weighing scales all blend in harmonious accord!

And now our kitchens turn to the rainbow. The enamel-ware industry has opened a color cupboard. Our pots and pans and our stoves have cast aside their Simonpure guise, and color plays an important part in the preparation of our daily menus. Being a woman I know that we shall never go back to those commonplace, uninteresting cooking utensils any more than we shall stop bobbing our hair. The glass industry has been revived by amber, ruby, emerald and rose. Millions of candles burn nightly because they give added color, harmony or contrast to glassware, china or napery.

House paint, once restricted to a small palette, now vies with all the nuances of Dame Fashion. By its color magic old furniture becomes new. Kitchen chairs are elevated to the elegance of the drawing room. Unpainted furniture is sold in carloads so that newlyweds can revel in an orgy of house decoration.

Typewriters now sing to the tune of prismatic blues. Umbrellas no longer lugubrious, blossom like spring flowers to cheer one on a rainy day. Rubbers and arctics become decorative and are colorfully atune with the ensemble.

Metal beds and steel desks are popularly active because they don't look like metal. Color did the trick. Soft, restful greens and sunny yellows are now dispelling the austerity of hospital white. The therapeutical value of color is being acknowledged by our medicos, a fact which helps to disclaim the valuation placed on their professional suffix by the small boy who defined the letters M.D. as "mentally deficient."

The well-balanced color scheme has entered the home, the business office, the factory, proving the modern theory that the more we allow our aesthetic taste to assert itself the more harmony and efficiency we generate.

Linoleum, once the plebeian of floor coverings, has been elevated to the aristocracy because of its new treatment and application of color and design.

And so runs the tale. All of which is another way of saying that color has acted like a blood transfusion to many industries and trades. It has revived some that were rapidly sinking into a coma or state of inertia that presaged the coming of the end. Industry has opened the door to color and will *never* close it. There can be no more graphic illustration of this than our automobile industry. It has developed a highly sensitized color appreciation with the result that it has been stimulated and aided through keeping in tune with the color scheme of fashion and woman's taste.

Where is this awakening and consciousness of color leading us? To beauty and to art; to increased sales, to quicker turnovers, if handled properly, intelligently and adroitly. To those untrained and unfamiliar to its industrial application color can be dangerous when not held in restraint. Color in industry needs organization. Mass production demands temperate and economic employment of color which can only be done by co-ordination.

So my advice to any industry or trade just opening the door to the chromatic scale is to organize, to agree and concentrate on a limited color range so that colors will not run riot; so that there will be a uniformity of shade and color harmony in order to prevent color from defeating its helpful and stimulating powers. Individualism in industry has passed. It is only through co-operative effort and organization that industries can reach their true economic place in the sun.

The medium through which industry can organize in color production can in no way hamper the exploitation of the creative and the artistic. Good design without good color application is lost because the eye absorbs and carries color to the brain far more quickly than line. There is no better selling point than color in the art industries.

Color is always generic. The characteristics of any period come to us in all forms of its artistic legacy. The temperament of a nation is reflected in its color sense. As a nation develops its love for art so must it develop a higher and finer color taste. One is the attribute of the other. The more we train and develop our color sense, applying it to our every-day life, in our dress, our home, our industries, as well as our arts and crafts, the greater we shall become a nation and center of culture.

And so, in closing, let me congratulate you on helping to make America the most industrial color-conscious nation of the world, and the day will come when the leading countries of Europe will be patterning their industrial efforts along the same economic color channels. But in parting I have one admonition: as chemists and colorists you have a grave responsibility to improve the color sense of the male species and reduce that 4 per cent of modern Adams who are, alas, too often lured by that forbidden fruit of the "tie that blinds," recorded so poignantly in Stoddard King's delightful ditty which goes like this:

O, some may long for the soothing touch
Of lavender, cream or mauve,
But the ties I wear must possess the glare
Of a red-hot kitchen stove.
The books I read and the life I lead
Are sensible, sane and mild.
I like calm hats and I don't wear spats,
But I want my neckties wild!

Give me a wild tie, brother,
One with a cosmic urge!
A tie that will swear
And rip and tear
When it sees my old bue serge.

O, some will say that a gent's cravat
Should only be seen, not heard,
But I want a tie that will make men cry
And render their vision blurred.
I yearn, I long, for a tie so strong
It will take two men to tie it.
If such there be, just show it to me—
Whatever the price, I'll buy it!

Give me a wild tie, brother,
One with a lot of sins,
A tie that will blaze
In a hectic haze
Down where the vest begins.

Mrs. Margaret Hayden Rorke—I just want to say that before I came up to the platform, a member of the press asked me if I was going to talk on the length of skirts. I said I didn't think that that was particularly interesting to chemists and colorists, but if it is, I will be very glad to answer questions, and on anything else you may want to ask me on fashion.

Chairman Williams—This is your opportunity, gentlemen. The next paper is by Charles A. Seibert on "Some Observations Pertaining to the Uniform Absorption by Rayon of Synthetic Dyestuffs." (Applause.)

Charles A. Seibert—Gentlemen, I wonder if my tie is in order. All signify by saying "Aye" and then I will proceed.

. . . Mr. Seibert read his paper as follows:

Some Observations Pertaining to the Uniform Absorption by Rayon of Synthetic Dyestuffs

By Charles A. Seibert
Colorist, E. I. du Pont de Nemours & Co.

THE following remarks are intended to apply to the viscose type of rayon.

Since its introduction, the varying affinity of this fiber for synthetic dyestuffs has been and continues a serious annoyance to the dyer. Originally this variation was accepted as an unavoidable natural characteristic which would be eliminated as a result of improved methods of manufacture. Unfortunately this expectation has not been fully realized, and it is questionable whether the improvements in the uniform dyeing qualities have equaled those of the physical qualities.

During the past several years special effort has been directed toward ascertaining the cause of this varying affinity, much written regarding it and numerous theories advanced in explanation. It is not our purpose to discuss these, however, as pertinent to our subject it is interesting to observe that the consensus of opinion still inclines to the belief that the cause is due to a multiplicity of uncontrollable variables during the course of manufacture. If this is a fact and only the perfection of mechanical intricacies is involved, which is questionable, it appears reasonable to assume that the production of rayon possessing uniform affinity for synthetic dyestuffs may not be expected in the very near future.

The dyer and technical chemist not being in a position to eliminate the cause have directed their efforts toward circumventing the effect.

Their efforts may be considered as having had two main objectives: to ascertain the most suitable available dyestuffs and the most suitable method of practical manipulation, prior to, during and supplementing the dyeing operation.

Our efforts have been principally directed toward ascertaining the characteristics of the individual dyestuffs of the direct and diazo groups with respect to their uniform absorption by rayon of known varying affinity. We have used the expression uniform absorption in preference to level dyeing because it more accurately describes the object of our experiments. A color may be uniformly absorbed by rayon of varying affinity and dye unlevel if improperly applied.

Some five or six years ago or perhaps at an earlier date someone observed that the varying affinity of rayon for synthetic dyestuffs was more evident when dyed with some colors than with others, and suggested that this was possibly due to differences in the molecular weights of the dyestuffs. This theory was discarded because when a large number of colors were investigated inconsistencies were found. However, this observation apparently directed the attention of others to this subject, as shortly thereafter, in 1927, Courtaulds, Ltd., of England, manufacturers of the viscose type of rayon, published the results of their efforts to ascertain the colors which were most uniformly absorbed. We are led to believe that this research was conducted under the supervision of C. M. Whittaker, and judging from literature which has since appeared he has continued this work with a zeal meriting commendation.

Whittaker's idea, briefly, is that the tendency of a dyestuff to be absorbed uniformly is inversely proportional to the capillary attraction of the dye in dilute solution toward rayon fibers: The determination of capillary attraction is carried out experimentally with equal lengths (25.5 cms.) of similar fibers of the same manufactured lot of rayon by suspending 3.2 centimeters into dilute solutions of the different dyestuffs at equal tinctorial concentrations. The length of the fiber left unstained is

accurately measured. Each dyestuff is given a number which corresponds to the number of centimeters of fiber left unstained in the capillary test made under standard conditions. Comparison of the capillary index numbers of dyestuffs with practical dyeing trials has shown that the dyestuffs with high numbers, i. e, those with low capillary attraction for rayon, have a tendency to dye it most uniformly. Whittaker also suggested that for use in combination it was advisable to select colors of the same index numbers or as nearly the same as are available.

For several years we have been interested in the subject and have conducted extensive research which not only verified the conclusions of Whittaker but also showed that there is a relation between the exhausting rate of a dyestuff, the temperature at which it exhausts to the maximum and its tendency to be absorbed uniformly by rayon.

When necessary to mention dyestuffs known by more than one name we have used the Du Pont nomenclature and Colour Index number.

We knew from experience that certain colors like Pontamine Fast Yellow 4GL (no Colour Index number), Pontamine Yellow CH (Colour Index 365), Pontamine Orange R (Colour Index 415), Pontamine Fast Red F (Colour Index 419), and Pontamine Scarlet B (Color Index 382), could be dyed in practice to produce reasonably uniform shades on rayon tubing which would show great differences in depth of shade when dyed with other dyestuffs, such as Pontamine Sky Blue 6B (Color Index 518). We endeavored to ascertain if those products which tend to dye rayon levelly possess traits in common when applied under varying conditions. This work led to the observation that the colors which are most uniformly absorbed have a maximum affinity for rayon at 160° F. and below. Those absorbed less uniformly are absorbed in increasingly greater quantity as the temperature is increased above 160° F., the maximum of some of the latter being as high as from 200° F. to 212° F. It was also observed that the level dyeing colors are absorbed by rayon much more rapidly than the unlevel dyeing group.

Our experiments included dyeings of all available direct and diazo colors, about 200 in all, but these did not include every known product of these two groups manufactured. For these tests we used rayon knit goods of known unlevel dyeing qualities. The methods of conducting these tests were as follows:

Two liters of solution were prepared containing 0.5 gram of the color, 0.5 gram of soap, 0.5 gram of Monopole oil and 5 grams of Glauber salt crystals. This volume of solution was divided into exactly ten equal portions of 200 c.c. each. Five of these portions were heated in a water bath to 180° F. and a 5-gram piece of rayon knit goods was entered and dyed for 5, 10, 20, 40 and 60 minutes, respectively. During this period the temperature was maintained at 180° F. The remaining five portions of dye solution were heated at 80, 120, 160, 185 and 212° F., respectively, and 5-gram pieces of rayon knit goods dyed in each for 45 minutes at these temperatures. For convenience we shall refer to these dyeings as the time and temperature variation tests, respectively.

These marked A you will note all practically dyed to the same depth, whereas in B (these are heavily dyeing colors) which is from the different groups, I don't know whether you can notice that, there is a gradual increase with this test.

Before I go on, I will explain the other side. We see, having dyed at different temperatures, the top 80, 120, 160 and 200, and you will notice these which are the heavily dyeing colors as I refer to them, all show the maximum affinity for the deeper shades at this point or below this point. Some will perhaps go up to this point, but those which are not of level dyeing qualities as we have found them show a progressive increase in strength with an increased temperature.

I will endeavor before I go on further to pick out one or two of these that will perhaps permit you to see that. You will notice that is very light at 80; between 120 and 160 and 200, it is almost the same.

Here is a very pronounced distinction, 80, 120, 160, 200 and at the boil. Very few of the dyestuffs show the maximum affinity at the boil. This happens to be the blue RW type.

I have one more I am particularly anxious to show you. There is Pontamine Fast Red BL which, of course, everyone is acquainted with, the temperature rate 80, 120, 160, 200. You notice the difference between that, if you can, and this.

The results of the time and temperature variation tests were used to classify all the dyestuffs examined into four groups designated A, B, C and D. In Group A were placed those colors which dyed the rayon as deeply in 10 minutes at 180° F. as they did in 60 minutes; in Group B were placed those colors which dyed the rayon progressively heavier as the time of dyeing was increased. In Group C were placed those colors which showed the most affinity for rayon at or below 160° F., and in Group D those colors which showed the most affinity above 160° F. The temperature of the maximum affinity of many of the colors was not clearly defined, because some indicated approximately the same affinity, which was the greatest, at temperatures between 120 and 180° F., others between 160 and 200° F., and some showed other variations.

Many of these dyestuffs had been tested by Courtaulds and had been assigned capillary index numbers. We

could, therefore, compare the results of our tests with those made by the capillary method.

After all the products dyed according to the methods outlined had been properly classified, it is interesting to observe that colors which appeared in Group A also appeared in Group C. In other words, those which dyed very quickly also had maximum affinity at or below 160° F., and many which appeared in Group B also appeared in Group D. The dyestuffs assigned to Groups A and C were as follows: Pontamine Yellow CH (Colour Index 365), Pontamine Orange R (C. I. 415), Pontamine Fast Red F (C. I. 419), Pontamine Scarlet B (C. I. 382), Pontamine Fast Yellow 4GL, Brilliant Benzo Fast Yellow GL, Icyl Orange G, R, Icyl Brown G, Icyl Red G, Icyl Violet B, Diazo Sky Blue 3GL, Icyl Blue G, Icyl Blue Black 6B and Brilliant Benzo Green B. All these dyestuffs which can be classified in both Groups A and C have been found in practice to be the most uniformly absorbed and to dye rayon the most levelly. We did not have available samples of six colors which the capillary test indicated as level dyeing, and it is possible that these and others not included in our experiments may merit classification with the group just mentioned. Pontamine Fast Black LN (No Colour Index) was classified in Groups A and D and possesses level dyeing qualities only slightly inferior to those colors just mentioned.

The absence of browns, violets, bright blues and greens among the colors mentioned is obvious, but this deficiency has been partly supplied by the recent introduction of eight new dyestuffs designated as rayon colors; these include two browns, two Bordeaux, two violets, a navy blue and a black.

All possess the characteristics of those colors which have been classified in both Groups A and C. Patents have been applied for on these dyestuffs; they have no prototypes, and they are not as yet listed in the Colour Index.

There is not as yet available a blue similar in shade to the Sky Blue with more level dyeing properties.

Our next experiments were conducted on a practical scale to ascertain the most suitable method of application. The results indicated that neutral or slightly alkaline olive oil soap and double sulphonated castor oil (Monopole), containing from 35 to 50% of oil, retarded the absorption of the color and both to approximately the same extent when used in equal quantities, and that from two to three pounds of either per 100 pounds of rayon was sufficient to assist levelling and penetration.

Further trials indicated that the colors of Groups A and C were equally uniformly absorbed if the material was entered into the dye bath at 100° to 110° F. and the temperature gradually raised to from 180° to 200° F. or entered at the last-mentioned temperature. Colors of Groups B and D unquestionably were more uniformly absorbed when entered at low temperatures, 100° to 110° F. The experiments conducted, which are too numerous to describe individually, led us to the assumption that the most level dyeing colors, those of Groups A and C, are quickly absorbed at temperatures of 160° F. or less, and that as the temperature is increased above 160° F. they partly strip off into the dye bath, and are again uniformly absorbed by the rayon at higher temperatures when common or Glauber salt is added.

Although the addition of salt or Glauber salt to the dye bath increases the rate of absorption and the total amount of color absorbed, it does not affect the relative amounts absorbed at different temperatures. If a color is absorbed to the maximum quantity at any given temperature without the addition of salt or Glauber salt to the dye bath it will also be absorbed to the maximum at this temperature when salt or Glauber salt are present in amounts equal to or less than the weight of the rayon dyed.

Our experiments did not entirely confirm the contention that the most level dyeing colors were those which possessed the greatest natural affinity for the rayon and required the minimum quantity of salt or Glauber salt to secure a reasonable exhaustion. We have dyed uniformly in practice rayon crepes of known unlevel dyeing qualities with dyestuffs which had practically no natural affinity and with which it was necessary to use 200% of common salt on the weight of the rayon when dyeing in a proportion of one pound of rayon in 20 pounds of dye liquor.

I would like to stress that. We made some peculiar experiments. We took a Smith-Drum machine with the cage, which we could raise out of the dye liquor, and we jammed that full of rayon knit goods which we knew had varying affinity. We jammed it full, just as tight as we could pack it, after wetting it down. We started the dye bath after having it boiled and let the thing run twenty minutes and they came out just as even and nice as any piece I ever succeeded in dyeing.

Here is an example of such a color. To the right here are four pieces dyed at different temperatures with the dyestuff alone in equal quantities to those at the right, the only difference is here there was no Glauber salt used. On this side there was an addition of 40% of the weight of the rayon. I know positively that that color is about as heavily dyed as ever I saw. We succeeded in dyeing rayon crepes with that color to a navy which we simply couldn't dye with any other color.

We next dyed on a practical scale all of the colors listed in Groups A and C, including the eight new rayon colors, and six selected from Groups B and D, using the

following dyeing procedure which we have since found to produce uniformly satisfactory results with the average voils, knit and woven materials when dyed with the colors mentioned as most level dyeing. The weights mentioned are intended for 100 pounds rayon dyed in approximately 400 gallons.

Prepare the dye bath with 1 pound each of olive oil soap and double sulphonated castor oil. Enter the material at 100° to 110° F., treat for 10 minutes, enter the previously dissolved color in two portions at 10-minute intervals and dye for 10 minutes. Raise the temperature to as near the boil as possible, not less than 180° F. in from 20 to 30 minutes, dye for 20 minutes and add the required quantity of Glauber salt in two or four equal portions at five-minute intervals. Treat for 10 minutes and sample.

The weight of Glauber salt crystals required to give a satisfactory color value is approximately ten times the amount of dyestuff used.

These dyeings were made at the Buffalo plant of the Du Pont Rayon Company, which placed suitable material at our disposal. For these dyeings we used rolls of from 40 to 60 yards of knitted tubing, specially selected to show varying affinity when dyed with Sky Blue 6B. Parts showing pronounced variation, Barre, were suitably marked, the color stripped with hydrosulphite and the rolls dyed separately with each color in a Rodney Hunt reel machine in the proportion of approximately one part of material to 50 parts of dye liquor. After dyeing and drying each roll was carefully examined and from one to two yard pieces cut from those portions marked. The remainder of the rolls were then sewn together, restripped and redyed. To permit us to make dyeings of all the colors it was necessary to strip and redye some of the rolls as many as four times. To ascertain if this treatment had any effect on the varying affinity, the remainder of all the rolls which still contained marked portions were again dyed with the Sky Blue 6B and continued to show approximately the same variation in shade shown before use for our trials.

An examination of these pieces demonstrated that those dyed with the colors listed in Groups A and C were uniform or sufficiently uniform to be satisfactory for practical purposes, while the remainder dyed with the six colors from Groups B and D are not uniform but show a variation in the depth of shade.

Some further observations of the results of our experiments were that immersions for from ¼ to 1 hour at from 70° to 80° F. in ½ to 3% solutions of caustic soda improved the uniform absorption of some rayon which possessed varying affinity. This improvement was sufficient where the variation was not very great, to permit dyeing with some colors of Groups B and D satisfactorily uniform for commercial purposes.

A few experiments made indicated that additions of acetic or formic acid to the dye bath did not materially improve the level dyeing qualities of the unlevel dyeing colors when applied to rayon possessing pronounced variation in affinity.

The addition of small quantities of alkali to the dye bath, preferably from 1 to 2% soda ash (58%) of the weight of the material dyed, appears advantageous.

With the exception of Pontamine Fast Yellow 4GL, and similar types, Chlorantine Fast Yellow 4GL, Benzo Fast Yellow 4GL and Brilliant Benzo Fast Yellow GL, etc., none of the fast to light types of the direct dyeing colors are uniformly absorbed by rayon of pronounced varying affinity. With these colors the most uniform results may be obtained when they are applied at temperatures not above 160° F.

With the exception of the colors just named the fastness to light and washing of all the most uniform dyeing direct colors is moderate, approximately equal to that of Pontamine Scarlet B (C. I. 382).

Vat, sulphur and azoic colors (naphthols and naphthanils) are more uniformly absorbed by rayon of varying affinity than are the basic, diazo and direct colors considered as groups.

In summarizing the results of these experiments, we believe that the principal conclusions to be drawn are:

1. That they indicate that the colors of the direct and diazo groups which are most uniformly absorbed by the viscose type of rayon, are those which are absorbed rapidly and have the greatest affinity at temperatures at or below 160° F.

2. That their uniform absorption is assisted by their application at first at temperatures below that at which they have the greatest affinity, and toward the latter part of the dyeing period at temperatures as high as are practically obtainable or between 190° and 205° F.

3. That salt or Glauber salt to assist exhaustion of these colors is preferably added to the dye bath after the temperature has been raised to above that of the maximum affinity.

Before closing, I would like to illustrate the results of some practical trials indicating the differences between the two groups of dyestuffs. I have here two pieces of rayon which were dyed in the same bath with Sky Blue. These were very much longer pieces when I originally started with them. Of course, you can see one is about four times the depth of the other. That is the Sky Blue which we listed in Group B and D.

This is cut from that same material dyed with one of these other dyestuffs. There is very little, if any, difference.

Here is another illustration. I don't know whether you will be able to see that from here. Here is a piece of tubing which is representative of what we used for our

dyeings, which shows the pronounced Barre, pronounced difference. That has been dyed with a violet common every-day type.

Here is a piece from the same roll of cloth, cut off and stripped and dyed with another one of those dyestuffs which we listed in Groups A and C. This, while it appears practically the same as this dyestuff here, is not the same. It is a different one. I will be pleased to pass those around.

I don't believe there is much else I have to say, gentlemen, unless there are some questions. (Applause.)

Chairman Williams—Are there any questions or discussion on this paper?

One of the papers listed this morning was on "Fastness to Light of Dyed Textiles, Its Determination and Standardization," by Dr. Paul Krais. This paper is abstracted in the printed notice of meeting which you all have and on account of lack of time will be presented by title only. It will be printed in full in the Proceedings and the Research Committee will give due consideration to the points that Dr. Krais has raised. Is there any question or discussion in regard to this paper?

Fastness to Light of Dyed Textiles, Its Determination and Standardization

By Paul Krais, Ph.D.

Director of the German Textile Research Institute, Dresden

THE writer requests the international adoption of the plan for the grading of dyestuffs for fastness to light, as worked out by the German Commission. The plan is described in detail. It consists of the assigning of a Roman numeral to each color, ranging from "I," for the very poorest colors, to VIII, for those colors of the present greatest light fastness, the ascending scale rather than the descending scale is used in order to leave numbers open for the improved dyestuffs of the future. The method of determining the gradation of a color is to expose it with a sheet of paper coated with a lacquer prepared from Victoria Blue B. The degree of fade on this paper is compared with the degree of fade on a similar piece of paper which has been previously exposed in a series of half-hourly gradations under established circumstances. This reference scale is kept in the dark. Thus, a fade is always measurable, regardless of how, where or when made. This Commission has already established certain definite types as representative of each grade. These, of course, may be used as standards.

The author rejects all artificial light testing and considers that sunlight and patience are the only criteria. The chemico-physical reasons for fading are briefly touched upon.

Of all fastness questions the one of fastness to light has given (and is giving still) the largest amount of trouble, work and uncertainty. On the other hand, it is of foremost importance and perhaps more than any other fastness question, of international moment.

Since the writer of this has been engaged with the problem, off and on, for more than thirty years (his earliest work has been published in 1902, regarding the improvement of the fastness to light of cotton dyes) and since he has the honor of being a member of your Association, he feels entitled to speak quite openly and with out reserve.

There are three main points into which what I have to say can be divided, namely:

First—Which is scientifically the best method of determining light fastness?

Second—Which is the best practical method?

Third—Is a standardization practically possible and desirable?

I. Scientific Methods

The most important factors are the Source of Light and the determination of the Change of Shade by exposure.

Very many proposals have been made in order to establish a substitute for sunlight. Up to the present none of these has been quite satisfactory. The latest publication I have at hand is by P. W. Cunliffe, of the British Research Association for the Woollen and Worsted Industries (Jour. Soc. Dyers and Col., 1929, July, p. 215). He admits that even using the most recent model of the Fugitometer, and with all precautions as regards humidity, "by exposing under such conditions some of the originally anomalous patterns faded in the lamp as in sunlight. A few still faded differently, however, and work is continuing in an attempt to bring the instrument still further into line with sunlight." If I may say so, not the patterns are anomalous, but the source of light is. I have before me a large number of comparative exposure tests made by the dyeing department of the I. G. with sunlight, Fadeometer and Fugitometer. The discrepancies are very numerous and perplexing, and we come to the conclusion that it must lead to serious mistakes if the fastness of a dyed material should be established on account of the number of Fadeometer or Fugitometer hours it has been exposed to. It appears, moreover, that the efficiency of the Fugitometer is so much weakened by filters that during summertime sunlight exposure is much quicker. As an instance the following figures may be quoted: with a number of

Indanthrene dyeings the effect of 125 days' exposure to sunlight has only been reached after 2,400 Fugitometer hours, equal to 100 days of day and night exposure.

Everybody engaged with this work would, of course, be only too glad to have a reliable and effective source of light. Lately extensive trials have been made with high power incandescent electric lamps, which promise a better efficiency. I have had on trial a one-crystal tungsten filament lamp, yielding 8,000 Hefner lamp units. The effect of this lamp 40 cm. from the center was equal to half of the strength of full vertical sunlight (measured with the blue paper which I am going to describe further on). Corresponding exposure tests with the light fastness standards of the German Commission showed that for cotton the results are fairly equal, for wool also with one exception, while with silk (weighted and unweighted) and with viscose and acetate silk the results became the more incongruous the longer the exposure was carried on.

Consequently, I must say, that up to date there is nothing but sunlight and patience to be recommended.

Our second factor, the determination of shade change, offers some difficulties as well, which are, however, more important for the scientific side than for the practical one. In Germany the methods of measurement, according to W. Ostwald's theory, are mostly in use. They have been essentially improved and simplified by F. A. O. Krueger and A. Klughardt on the basis of the Pulfrich Photometer, made by Carl Zeiss, Jena. The difficulty is that only very few dyeings fade, so to say, in a straight line from their original hue to a more or less colorless white, most of them changing into dismal grayish shades. The latest effort in this line has been made by G. Ziersch, Barmen (Dissertation Dresden, 1929), see also Leipz. Monatschr. f. Text. Ind., 1929, No. 5, p. 220). On the basis of measurements with a number of cotton dyeings he has established a Light Fastness No. L, which is to be found by the formula:

$$L = \left(\frac{W'}{H'} - \frac{W}{H}\right).100$$

wherein W' and W represent the amount of white, H' and H the relative luminosity (Bezugshelligkeit) of the exposed and unexposed patterns.

This would correspond to the "method of expressing color change by a single number" as P. W. Cunliffe wishes it in the publication quoted above.

The question, What Becomes of the Dyestuff Molecule? when it is destroyed by actinic influence is also of some interest. The opinion of our prominent scientists, the late O. N. Witt, was, that the influence might be something similar to the effect of an alternating electric current, that is, oxidizing and reducing action in quick and ceaseless succession. This would mean a constant attack on the molecule at its weak points, and the same on the weak points of the secondary products, etc., until everything is converted into the most stable compounds. It seems, however, that oxidation plays the foremost part. This is made probable by the discovery of the peroxide of Malachite Green by K. Gebhard (1913), of the formation of Isatine from Indigo by Eva Hibbert (1927), the conversion of Anthracene into Anthraquinone by the same authoress, etc.

II. The Practical Method

The requirements of the dyemaker are in this case quite different from those of the dyer and the public. The dyemaker wants to produce dyestuffs, which are faster and faster, in order to improve his sets or to equal or even to surpass his competitors. He has to test first of all the dyeings of single dyestuffs, secondly their combinations mostly with dyestuffs of his own make. The dyer and the public want dyeings, such as are commanded by the fashion of the season, or by the coloristic requirements of a room's interior, etc. Dyeings with one dyestuff are an exception, and in many cases the dyer does not even know what the yarn he dyes will be used for.

Therefore, it is necessary for practical purposes to make the testing method as easy, simple, intelligible and popular as possible. This was the leading factor for the work done by the German Commission.

When the Germans gave No. I to the lowest, No. VIII to the highest light fastness, why did they do so? In business in every market No. I are the best goods. An example: the degree of fineness of flours was formerly numbered from No. I to II, III, etc. Then mills came up which ground the flour finer still, and now we have the numbers 0, 00 and 000. When a merchant brings out his goods as prima and then improves on them he must call the new brands Primissima, etc. Whereto could the norms go when No. I is surpassed? But this is not even the real point of the question. We don't want to make a classification, but a gradation, and that is why we begin with I at the bottom.

A second point of doubt is the choice of standard dyeings the German Commission has come to. I am sure the English and American Commissions think to be able to improve on this. No doubt they will be able to, but what will it avail? These standards are chosen with the utmost consideration and on the basis of very many years' experience. And with these very standards we have now had sixteen years' experience on the top of that, in any way with those on cotton and wool, and we are quite satisfied with them as a working set, though

they might not fulfill every ideal. All these things are and must be compromises. Not a single discrepancy has crept up through all these years, though these standards are recognized by the Patent Office, by technical schools, dyeing schools, official clothing departments, textile experts, etc. The firms of the I. G. are using these standards now regularly.

Would it, therefore, not be the best way, the simplest and quickest, if the commissions of the other countries would adopt them *en bloc,* as far as practical testing is concerned? To give you an idea of their character I may just enumerate them here. The figures in parenthesis refer to the numbers in G. Schultz' Tables of 1923.

Type	Cotton
I.	5% Chicago Blue 6B (424).
II.	0.8% Methylene Blue BG (on tannin-antimony).
III.	1% Indoine Blue R in pwd. (126) (tannin-ant.).
IV.	20% Kryogene Blue 3R.
V.	2.5% Sirius Red 4B.
VI.	10% Hydron Blue G 20% Paste (748).
VII.	8% Sulfur Black T Extra (720).
VIII.	25% Indanthrene Blue GC Pste. (843), IN-process.

Type	Wool
I.	3% Indigotine Ia Pwd. (877).
II.	1.5% Ponceau RR (82).
III.	2.75% Amarant (168).
IV.	4.5% Azo Acid Red B (64).
V.	5% Acid Violet 4RN.
VI.	2.5% Diamine Fast Red F (343) afterchromed.
VII.	4% Anthraquinone Green GXN (864)
VIII.	Indigo (874) in the depth of a shade of 2.4% Sulfon Cyanine GR Extra (257), or 7% Naphtole Green B (4).

Type	Silk (Unweighted)
I.	0.5% Victoria Blue R (558).
II.	2% Fast Red O (161).
III.	2% Acid Alizarine Gray G
IV.	2% Violamine ARR.
V.	2.5% Indanthrene Brilliant Violet RR Pwd.

Type	Silk (Weighted)
I.	0.2% Victoria Blue R (558).
II.	3% Brilliant Sky Blue 5G.
III.	4% Thiazine Red R.
IV.	4% Croceine Scarlet 3B.
V.	5% Brilliant Croceine 3B.
VI.	6% Sirius Red 4B.
VII.	6% Sirius Orange 5G.
VIII.	6% Sirius Yellow RT.

Type	Acetate Silk
I.	1% Methylene Blue BGX.
II.	0.2% Cellitazole B devel. 1.5% Developer ON.
III.	0.5% Cellitazole RB dev. 1.5% Developer ON.
IV.	2.5% Cellite Fast Rubine B.
V.	1% Cellitone Scarlet B Pwd.
VI.	16% Cellitone Fast Marine Blue B Paste
VII.	3% Cellitone Fast Violet ER.
VIII.	3% Cellite Fast Blue A.

Type	Viscose Silk
I.	0.4% China Green cryst. (495) on tannin-antimony.
II.	4% Diamine Rubine S.
III.	2.25% Brilliant Penzo Fast Violet BL.
IV.	1.5% Naphthol AS-RL per liter, devel. 2 g. Fast Red RL Base.
V.	20% Indanthrene Blue GC (843) process IN.

The eight standards for weighted silk and acetate silk are new. For unweighted silk and viscose silk so far only five standards have been established.

Nothing is simpler than to use these standard dyeings for the determination of the fastness of a given dye or a series of dyes. When testing, the standards in question are exposed along with the patterns, both partly covered. It is very easy to find the range. Frequently one will find that the result is not exactly in accord with one of the standards, but stands between two of them, the verdict being then, for instance, III-IV. In any way, one is quite independent of the weather, of the kind of glass, behind which the patterns are exposed, of the angle in which the light falls on them. Three grades, viz., "beginning to fade," "distinctly faded" and "strongly faded" are quite sufficient for a verdict, thus no complicated photometric apparatus is necessary for the practical tests.

For short exposure periods, and if the same period is to be repeated at different times of the year or under different conditions, a measuring scale can be useful which I have recommended in 1911 (Zeitschr. f. angew. Chemie, 1911, p. 1129). This consists of a paper painted with a blue lacquer made of Victoria Blue B and China clay. This is very sensitive and gives a distinct gradation by exposure to sunlight. Of this paper a scale is made by exposure to full vertical sunlight for one-half, one, one and a half, two, etc., hours up to four hours. This scale is kept in the dark, and a slice of the blue paper is exposed along with the dyeings to be tested. Thus from day to day the number of "bleaching hours" can be registered. On very bright summer days two slices may be necessary, because then one might have more than three to four bleaching hours. In this way a period of, say, ten bleaching hours can be repeated independent of weather and season. Of course, this scale is restricted to the town or place where it has been made. The bleaching goes on by about 30% quicker in Arosa than in Dresden.

III. Is Standardization Practically Possible and Desirable?

Our experience has shown, that in many cases the standardization of fastness properties is very useful. It tends to a general improvement of the quality of dyeings and gently forces the dyer as well as the manufacturer, to do his best and to confess openly, in which cases he is not yet able to fulfill all the wishes of the public.

The practical possibility has also been proved by the success of the work of the German Commission. I am convinced that it would be the best plan for similar commissions in other countries to adopt the German standards, at least as far as fastness to light is concerned and as far as the practical application goes. If at any time alterations should seem to be necessary, these should be made by international agreement.

If, instead, two or three commissions in different countries propose and adopt different standards on different lines and principles, then there will soon be a babel similar to that of inches and centimeters, gallons and liters, degrees of Fahrenheit, Reaumur and Celsius.

PIEDMONT SECTION
ANNUAL MEETING

Chemistry in Cotton Piece Bleaching

By George P. Feindell
Chemist, Union Bleachery

THE chemistry of bleaching is in itself a very broad subject. It will be impossible for me to tell all of the ways in which chemistry is involved in bleaching. I will merely point out some of the practical chemistry as applied in the chlorine bleaching of cotton piece goods.

The first step in bleaching is preparation. A good bleach cannot be obtained unless the goods are first properly prepared.

Preparation usually consists of singeing, steeping, gray scouring, and kier boiling, although sometimes steeping and gray scouring are omitted and the goods are taken directly from the singer to the kier.

The operation of singeing consists of passing the cloth over a series of flames or heated plates to remove the projecting fibers from the surface of the cloth.

In steeping the cloth is taken from the singer, passed either through hot water or through a desizing solution and allowed to steep from 12 to 18 hours. The purpose of this treatment is to allow fermentation to convert the starchy matters into a more soluble form. From the steep the cloth is given a cold treatment in dilute sulphuric acid, usually at from 1° to 2° Tw. It is then allowed to lay for a short period of time. This treatment partly hydrolyzes the starchy and sizing materials.

After sour, the goods are washed and taken to the kier where they are boiled under pressure in a solution of about 3% caustic soda, figured on the weight of the goods. Kier boiling saponifies the fatty and waxy matters. It also dissolves the pectin compounds, thus leaving almost pure cellulose except for a brown-colored matter which must be removed by bleaching to give a good white.

From the kier the goods are washed and passed through a cold solution of sodium hypochlorite or bleach liquor. The strength of the bleach liquor varying according to the weight and construction of the cloth, usually from 1° to 2½° Tw. After passing through the bleach liquor, the goods are squeezed and piled into bins, where they are allowed to lay from 6 to 12 hours. They are then washed and soured in dilute sulphuric acid, and treated with an antichlor solution, which may be either sulphur dioxide dissolved in water or a solution of sodium bisulphite. In the case of light goods, the sour is sometimes omitted, the goods being simply washed and treated with an antichlor.

The general routine of preparation and bleaching in most bleacheries is along the order just given. Usually things go along very well. However, there are times when difficulties arise which are hard to locate.

For instance, the dyer may report that the goods are not properly prepared and that they take the dye unevenly, or that the cloth has resist spots, or tender places, or places that dye darker than the rest of the fabric.

The starcher may report that the goods do not take the blueing properly, and so on.

Often these troubles encountered in bleached goods do not originate in the preparation or bleaching, but go back to the gray cloth before it is processed.

Sometimes the cloth contains improper sizing materials which are difficult to remove, or the cloth may have become wet in storing or stained with mineral oils and rust.

Improper sizing materials are paraffin waxes, tallow substitutes as mineral oils, and chlorides of magnesium, calcium and zinc. Paraffin waxes and mineral oils, being not saponifiable, are extremely difficult to remove. If traces are left in the cloth, they form resist spots or mordants which later give serious trouble in dyeing and printing.

Chlorides of magnesium, calcium and zinc are easily broken down by heat, thereby liberating free hydrochloric acid which tenders cotton.

Proper sizing materials are starch, tallow and saponifiable oils.

Gray cloth that has become wet through storing is very apt to mildew quickly because it contains considerable amount of starch and when excess moisture is present, there is an excellent opportunity for the growth of mildew. In some cases it progresses to such an ex-

tent as to actually weaken the cloth. Several cases of mildew are difficult to remove without injuring the fabric.

Rust stains are removed with oxalic acid, however, if oxalic acid is not completely washed out or allowed to dry in the fabric, it will cause tendering, which usually shows up after singeing.

Having briefly summarized the difficulties encountered in the gray goods I will now go on and deal with the difficulties experienced in the actual preparation and bleaching.

In singeing, care must be taken that the cloth is not scorched, and that the flame is of uniform height. Scorching will cause loss in tensile strength. Uneven flame will cause streaks that may later show up in dyeing.

Care must be taken in steeping, that the goods do not lay too long in the bins. Also that the bins are clean. During warm weather, mildew will set in, and often it passes unnoticed until after the goods are bleached. A thorough and regular cleaning of steeping bins is a very good practice.

In the gray scour it is essential that the acid is diluted before adding to the scouring bath. A separate mixing tank to dilute the concentrated acid prevents the possibility of any of the strong acid being spattered on the cloth.

The kiers should be loaded in such a manner that the goods will not channel, thus getting even distribution of liquor throughout the kier. Liquor enough should be used to completely cover the goods, yet too much should not be used, as it will cause the goods to float and chafe them against the sides of the kier. All the air must be excluded before pressure is put on, as oxygen in the presence of hot caustic causes formation of oxycellulose. The sides of the kier should be smooth and well coated. The water should be soft and free from iron, as hard water causes insoluble soaps and iron causes yellow stains which only a sour will remove.

In the making up of the bleach liquor, it is very essential that it runs uniform in available chlorine from mix to mix, also that it is free from contamination. Iron is one of the greatest sources of contamination. It is usually present in the form of rust. Pipes conveying the bleach liquor from the storage tanks to the chemic machines should be of pure lead or Duriron, or of such material that it will not be attacked, thus introducing particles of metal into the bleach liquor.

Iron, iron rust, or particles of metal getting into chemic act as a very speedy catalytic agent. Thus when particles of metal get on the cloth in the presence of chemic, the cloth in that particular spot is very much overbleached, in fact so much that oxycellulose is formed. Oxycellulose not only resists direct, sulphur and vat dyestuffs, but loses its tensile strength, often causing small holes to appear in the goods when finished.

Complete removal of chemic, acids and alkali after bleaching is very essential. Chemic, if dried in the cotton, also forms oxycellulose. Mineral acids, as sulphuric acid, when dried in cotton, not only tenders, but forms hydrocellulose, which gives trouble in dyeing.

Cloth that has alkali dried in will not take blueing properly. Also it has a tendency to become yellow rather quickly on aging.

Thus you can readily see how essential it is that each step in the bleaching of cotton piece goods must be very closely watched in order to obtain the best results possible.

As time does not permit me to go further with this extensive subject, I do hope that, in a small measure, I have made you realize to what a large extent chemistry is involved in the chlorine bleaching of cotton piece goods.

Chemistry in Textile Finishing

By Charles L. Schuttig

Chemist, Special Department, A. Klipstein & Co.

MR. CHAIRMAN, Members of the Piedmont Section American Association of Textile Colorists and Chemists, and Bleachers, Dyers, Finishers and Mercerizers of the Southern Textile Association, and guests:

There is an old saying that "Brevity is the soul of wit," and since no less an authority than Percy Bean in Volume One of his latest work on "The Chemistry and Practice of Finishing" used something over six hundred pages describing the details of the finishing of cotton piece goods alone, I am afraid that in the brief time at my disposal it will be more or less impossible for me to indulge in any lengthy details of the subject assigned to me, which is "Chemistry in Textile Finishing."

This being a Southern meeting it may be reasonably assumed that we are not particularly interested in the finishing of worsted or woolen fabrics since this industry is more or less located in New England. I also feel that it would not be interesting to use this time by going into the chemistry and finishing of silks fabrics which we all know is more or less confined to New Jersey and Pennsylvania.

Chemistry plays an important part in the manufacture of the rayon and Celanese fibers, but does not enter very greatly into the finishing processes of the fabrics. These fabrics generally take pure finishes, the only chemical processes being removal of oils and sizes applied to rayon and Celanese by the manufacturer, and since the chemical control of these processes is similar to cotton it is ad-

visable to pass right on to chemistry as applied to the finishing of cotton piece goods.

The cloth should come to the finisher properly bleached, mercerized and dyed. The best condition of the cloth for finishing purposes of course is neutral. However, quite often the cloth comes up to the finishing room containing impurities which are quite detrimental for the production of a perfect finish. Often the cloth comes from the bleach house in the acid or alkaline condition, or it may contain sulphates and other salts. Mercerized yarns which are manufactured into piece goods have been known to contain insoluble oils and greases which form resists in the cloth. On the other hand chemicals used in the dyeing operation may not have been entirely removed. All these conditions influence the actual finish, and unless the finisher is familiar with the exact condition of his cloth it is impossible for him to produce the best results.

This, therefore, becomes a matter of chemistry, and it is at this point that the services of the plant chemist becomes of value in connection with the actual finishing of the cloth, and it is his first duty to examine the cloth by actual analysis and correctly determine its condition. He should then report same in detail to the finisher so that he could correct his cloth and formulate his finish accordingly should it be necessary.

As you all know, a finishing mill uses many different chemicals in the production of its various finishes, and it is only by close chemical control that the best products may be selected and the fullest value realized by the mill for the money it spends on these materials. Therefore, the second important duty of the chemist becomes the analysis and evaluation of these products.

The materials and chemicals ordinarily used in finishing can be divided into four groups—the first group comprising adhesives, binders and stiffeners such as cornstarch, potato starch, sago, tapioca, rice, dextrines, in addition to the various gums like tragacanth, tragasol, Irish Moss, glue, glucose, etc. The second group contains the fillers and weighters such as China clay, talc, barium sulphate, calcium sulphate, magnesium sulphate, sulphate of soda, etc. The third group represents the ingredients used in softening, including the oily and greasy substances of tallow, tallow substitutes, Japan wax, paraffine wax, sulphonated castor oil, mineral oils and similar products. The fourth group contains the deliquescent materials generally used because of their hygroscopic, or water attracting properties, including products like calcium chloride, magnesium chloride, zinc chloride, Epsom salts, etc.

Tests of all these materials should be made before using in order to determine their fitness for the use intended. They should all be tested for purity, possible adulteration, strength, etc. While the products known as softeners and finishing oils should be especially examined for odor, color and the possible development of rancidity after finishing which would cause bad odors and yellowing in whites.

A third and vital duty of the chemist is that of the chemical control of all finishing formulas in order to eliminate the possibility of defects in the finish developing after the cloth has left the mill. I refer to colors turning off-shade, tendering of the cloth, mildew stains, yellowing of whites, developing of rancidity with the consequent bad odor, etc., and the chemist by a close study of the materials used, mill conditions and storage conditions after the cloth is shipped can easily devise methods and formulas that will prevent these defects.

Fourth, the progressive mill is the one that is constantly bringing out new formulae, as well as duplicating other successful finishes. The chemist can co-operate closely with the finisher in the development of new finishes, duplication of finishes, as well as general research in this connection, which will also include the close study of general plant conditions with the idea of keeping at a minimum the general mill costs because, though the finishing room may operate very economically, excessive operating costs in other departments would naturally increase the actual finishing costs.

Finishing is a practical art, therefore, a thorough knowledge can only be acquired by practical experience for the correct use of the various machines is important for the production of the desired finish, as well as the selection of proper chemicals and formulas. It would seem also that the ideal situation is for the finisher to have a rather comprehensive knowledge of applied chemistry so that he may be better able to co-operate in the advancement and success of the mill from the finishing standpoint.

It is very evident that the knowledge of chemistry will go a long way toward the success of the finisher, and I think you will agree with me that the men who have made the greatest success in this line in recent years have been amply fortified with a basic knowledge of chemistry.

Chemistry in Its Relation to Dyers

By Samuel L. Hayes

Resident Manager, U. S. Finishing Company, Hartsville, S. C.

IN attempting to discuss the role of chemistry in relation to the dyeing industry one has an easy task. In a broad sense, the relation of chemistry to the dyeing industry should include chemistry as related to the preparation of the raw materials used by dyers and in dyeing.

In other words, it would include the chemistry of the manufacture of dyestuffs, chemicals, wood extracts, and all materials used in the coloring of textiles. It should also include something of the theory of dyeing.

The time allowed for this paper is too short to discuss the above problems. If one is interested in chemistry as related to the manufacture of dyestuffs we would refer them to the book on "Creative Chemistry" by the late Edwin E. Slosson, which, in an interesting and not too scientific manner discusses this subject, and to a paper presented at the last general meeting in Charlotte, by Mr. Phillip Stott, a member of our Association, who discussed it in a language which a layman can understand.

If you are interested in the theory of dyeing, which, after all, is a matter of dispute, we would refer you to any of the standard works on dyeing. Is dyeing chemical, is it physical, is it electrical, or is it a combination of all three? For some of the latest information on this phase of our subject we would refer you to a recent issue of the AMERICAN DYESTUFF REPORTER and to several papers read and published during the last two or three years by Mr. Walter Scott and Mr. Henry Herrmann of our Association. Nor will we touch upon the important, and, perhaps we may say, vital influence of pH control. That phase of the discussion we leave in the hands of our Chairman.

In this short paper we shall confine ourself to chemistry specifically as related to dyers, and shall try to show that a good dyer should be a good chemist. We shall try to show through a series of practical applications that any dyer who does not have a knowledge of chemistry is handicapped in his work and that it would be to his advantage to school himself in that science. We have changed our paper from "Chemistry in Relation to Dyeing" to "Chemistry in Its Relation to Dyers."

There are certain qualifications which are inherently common to all professions. There are special qualifications which a dyer must possess. First and foremost, a good eye for color and color value. Either one has this asset naturally, or they will never have it. True, it can be developed and trained, but it cannot be acquired. A dyer must also be familiar with the materials he is handling, and without a knowledge of chemistry he cannot possess this qualification.

There have been, and are now, any number of good dyers who have been successful in their work and who have no knowledge of chemistry. There will always be dyehouses where the nature of the work is so limited that one may be a good dyer in that particular plant, but the successful dyer of the future who expects to fit himself for a desirable position, must combine with his other assets and understanding of chemistry. The time has passed when a knowledge of one or more fibers and one or more classes of dyestuffs is sufficient. Let us in imagination picture the problems which may confront a dyer in a piece goods plant during the course of a day's work.

A complaint comes in that a lot of mineral khaki was improperly dyed, as evidenced by a so-called faded garment. His knowledge of chemistry leads to the correct solution that the laundry had used oxalic acid as an anti-chlor, and as the oxides of iron and chromium are soluble in oxalic acid the garment was almost colorless.

He finds he is out of hydrochloric acid, and his knowledge of chemistry tells him to use sulphuric acid in his bleach house, and on some of his diazotized and developed work. It tells him not to substitute sulphuric acid in his Aniline Black where the lower solubility of aniline sulphate would cause trouble.

His knowledge of chemistry tells him not to dye Benzopurpurine 4B on one set of jiggs and diazotized and developed colors on the adjacent set, as he realizes the effect of the acid fumes on the Benzopurpurine; it tells him to wash out all salts from his goods before he soaps them; it tells him when under varying market conditions formic acid or acetic acid is the best buy; it tells him the difference to make in his formula if he changes his oxidizing agent from potassium chlorate to sodium chlorate; in an emergency it allows him to change his oxidizing agent from bichromates to perborates or persulphates, with a minimum risk to the plant; it tells him when to use straight hydrosulphite and when to use formaldehydrosulphite.

Similar instances as the above could be given almost without limit. His knowledge of chemistry enables him to understand the reduction of his Indigo vat, the diazotization and coupling of his developed colors, the dispersion of his Celanese dyeing colors; the precipitation of metallic soaps in waterproofing; the condition of his Paranitraniline bath; the reaction between metallic salts in silk weighting; the effect of certain metals, such as iron on tannic acid, copper on sulphur colors and Monel-metal on certain diazotized and developed colors; the production of a heavy insoluble ash content in fireproofing; the after-treatment of a wood or extract dye; the control of the reduction of vat colors; the production of wool in vat dyeing on a mixed fabric; the protection of rayon in the mercerization of a rayon and cotton fabric, and innumerable other problems which are part and parcel of our daily work.

If we now list wool, shoddy, cotton, silk, rayon, Celanese, weighted silk, unweighted silk, immunized cotton, ramie, jute, as the different fibers and remember that a dyer must perform his work not upon a cloth made of one fiber, but consisting of two or more of the above figures.

In like manner we may list Direct, Acid, Basic, Diazotized and Developed, Sulphur, Vat, Indigosol, Naphthol, Wood, Mineral, and other classes of dyestuffs. With the above fibers and dyestuffs he is called upon to produce various results—one fiber dyed, one left white; one dyed one shade, one a contrasting shade. His goods must when necessary be fast to stoving, fast to cross-dyeing, fast to washing, fast to light, fast to vulcanizing, capable of being discharged, and yet always produced at the lowest cost consistent with the desired results.

To-day this, without a thorough knowledge of the materials he is working with, without a thorough understanding of their properties, is out of the question. And if he has a thorough understanding of the properties and changes which take place in the materials he is using he has a thorough understanding of chemistry, for, after all, a thorough understanding of chemistry is based upon a knowledge of the properties and changes in matter.

We have purposely given in mere outline a few of the chemical problems dyers must solve, and leave the subject for detailed discussion in our afternoon meeting.

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AMERICAN DYESTUFF REPORTER

Devoted to the use and application of dyestuffs and the mechanical equipment incidental thereto.

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CO-OPERATIVE TEXTILE RESEARCH

THOSE who read carefully the remarks of Dr. E. H. Killheffer, President of the American Association of Textile Chemists and Colorists, at the Annual Meeting of the Association, as published in the last issue of the REPORTER, must have been convinced that this Association, at least, is fully awake to the need of pure research by the textile industry. And those who examined the complete text of the various letters received by Dr. Killheffer in response to his questionnaire on the general subject of co-operative textile research, could not fail to have been deeply impressed with the virtual unanimity of sentiment on the part of leading textile executives for some constructive action along the line contemplated.

Careful study of the replies in question reveals a multitude of minor differences of opinion as to ways and means and a very strong undercurrent of doubt as to the possibility of definite accomplishment because of the magnitude of the various and sundry difficulties to be overcome. With hardly a single exception, however, there is evidenced a strong conviction that the day of co-operative research will eventually arrive for the textile industry and that it is one of the most pressing needs of the industry as a whole.

The thought is even brought out by one or two of the best informed authorities that the seriously unsatisfactory conditions in the textile industry which have existed since the period of post-war deflation might have been ameliorated to no inconsiderable extent had co-operative research on a broad scale been undertaken by the industry fifteen or twenty years ago. Many other industries which have weathered the post-war conditions in far more satisfactory financial shape than has the textile industry were well organized for co-operative research long before the outbreak of hostilities.

The truly amazing feature, and one might almost say the heartbreaking feature, of practically all expressions of opinion is the willingness to believe that real results are impossible of achievement. Almost without exception textile executives are outspoken in their belief that results of greatest importance to the industry might be accomplished by co-operative action, but in the same breath they, with equal unanimity, profess to believe that for one reason or another no tangible results can be expected at this time.

The situation which now exists and has for some years existed in international circles regarding the question of naval and other armament limitations is most analogous. No state has yet been heard to express the opinion that a reduction of armaments was undesirable, but for one reason or another almost all of them find an objection to any practical solution which has yet been offered.

There can, however, be no doubt in the mind of any intelligent and broadminded person that the day of great navies and great armies is drawing to a close, and that from now on steady progress will be made in the direction of limitation and reduction of armaments.

While this analogy holds in a general way there is one grave difference. In the case of armament reduction the very life blood of sovereign nations is involved. National honor—that flint whose spark has lit so many world-wide conflagrations—is at stake. The question of textile research, on the contrary, involves nothing more serious than the betterment of a single industry. The potential gain is out of all proportion to the trifling risks involved. In view of this, it is amazing that certain elements should be so hidebound in their persistent adherence to a belief that they can best benefit from research which is confined solely and secretively to the limits of their own organization. However, just as the day of armament limitation is sure to arrive, just so surely will the time of co-operative research for the textile industry come to be.

Dr. Killheffer's remarks throw a clear light on the distinction between pure science research and applied research. It is in the field of pure science that co-operative efforts must find their greatest reward. Few, if any, individual corporations can afford to spend the time and money requisite for pure science research, and even if they can so afford, the results accomplished by single units working independently are in no sense comparable to the results which may be achieved by 100 per cent co-operation.

Discoveries in the field of pure science are seldom of immediate practical value to any individual or corporation. They do, however, furnish the fundamental bases upon which applied scientific research may be undertaken by individual laboratories and from which the greatest commercial achievements may grow.

The REPORTER recalls that ten years ago, when it was advocating the establishment of an American society of dyers and textile chemists, there was the same general

feeling among the fraternity that such an organization was desirable but that for one reason or another the time was not opportune or the proposed machinery was not adequate. Eventually, however, a group of energetic and progressive chemists under the leadership of our editor, Dr. Olney, took the initiative in calling a meeting of their brothers with the result that the American Association of Textile Chemists and Colorists was formed, and has grown steadily in membership and accomplishment to the present day.

It is the firm conviction of the REPORTER that if various elements in the textile industry will forget their petty differences of opinion as to ways and means, and in a broadminded spirit of co-operation authorize some impartial body now existing or to be created, to take definite steps toward initiating co-operative pure science research, the effort is bound to succeed. And it is our firm belief that before this body has been functioning a single decade its obvious value to the textile industry will have been so conclusively demonstrated that further appeals for funds will be unnecessary and that our leading textile establishments will, as a matter of ordinary business judgment, see to it that a portion of their annual budget is each year assigned to this all-important work.

Some merchant Croesus is responsible for the adage that the first hundred dollars is the most difficult to acquire on the road to wealth, and some facetious humorist has paraphrased this with the expression that the first thousand years is the hardest. There is a tremendous amount of truth in both statements. It is always the beginning that is difficult. To overcome inertia by setting a standing body in motion, as every physicist knows, requires the expenditure of much energy, whereas little or none is expended to keep it in motion once it is started.

The REPORTER believes that the American Association of Textile Chemists and Colorists including in its membership, as it undoubtedly does, a majority of the foremost scientific minds of the textile industry, is best equipped to undertake the supervision of any co-operative textile research program which may be undertaken. It also realizes, however, that there are many unquestionably able individuals and many powerful interests who might not share this sentiment. It therefore urges upon all organizations who have either a direct or indirect connection with the textile industry, and all individuals who have influence with such organizations, to forget all personalities and to unite in effecting the organization of some sort of a central research body which shall be truly representative of the textile industry as a whole and which will at least make a beginning in the direction of co-operative pure science research.

The committee of three which it was directed at the recent Annual Meeting should be appointed from the American Association of Textile Chemists and Colorists to confer with other similar committees which it was hoped would be appointed by other textile organizations will have our strongest support, and we earnestly bespeak a similar support from all textile publications and other textile organizations. A. P. H.

The New Bedford Textile School Alumni had their annual dinner in December, and the secretary requests all alumni in New York City to get in touch with him in order that they may receive notices of monthly luncheons. Send address to Arthur H. Ronne, care of McCampbell & Co., 320 Broadway, New York, N. Y.

Morris Campbell, southern sales manager of the Carbic Color & Chemical Company, recently resigned to take over the management of his recently deceased father's business in Greenville, S. C. Mr. Campbell is a recent graduate of the Clemson College (S. C.) Textile School, and was one of the most successful of the younger salesmen in the South.

DR. BERTHOLD WUTH

Readers of the REPORTER will be saddened to learn of the death of Dr. Berthold Wuth which occurred on Saturday, December 28, at Badenweiler, Germany. Dr. Wuth had for many years been associated with Ciba Company, Inc., in a technical capacity and was recognized throughout both Europe and America as a leading authority upon textile chemical subjects, especially textile printing. He had but recently completed the text of a most comprehensive treatise, entitled "Textile Printing," which is shortly to be published by his late employers.

Dr. Wuth was a member of many scientific societies, including the American Association of Textile Chemists and Colorists. At the Annual Meeting of this latter Association, held in Philadelphia the first week in December, he had been awarded a prize by the Committee on Prize Awards of the Association for a paper delivered during the year, entitled "Optical Heterogeneity and Its Influence on the Fastness to Light of Vat Colors." It is doubtful if he lived to know of this award.

Details regarding his death have not as yet been received, but it is known that he had been in ill health for a considerable period.

PROF. CHARLES S. DOGGETT

Friends will learn with regret of the death of Prof. Charles S. Doggett, for many years associated with the Textile Chemistry Department of Clemson College. His death occurred on November 22 at his residence at Clemson College, S. C.

Technical Notes from Foreign Sources

Colored Designs Upon Aniline (Prudhomme) Black

Dr. H., Textil-Chem. u. Colorist 10, 138 (1929); *Abstracted from Rev. Gen. Mat. Col.*—The best known and simplest method of producing colored patterns upon an aniline black bottom depends upon the use of basic dyestuffs. The disadvantage of this method, however, consists in the fact that the extremely fast black is used in conjunction with dyestuffs which are not very fast to washing or to light. Fastness to washing might be improved by using certain fixing agents of the nature of Katanol, but the use of this in the present case is made difficult by the usual reserve pastes not tolerating such an addition. Sazanoff and Braun have succeeded in getting around this difficulty to a certain extent, yet the results obtained, especially in reference to fastness to light, leave something still to be desired. The chrome dyestuffs, essentially faster than the basics, as to themselves at least, have not been able to gain any extended use, for their color tone does not possess the luminosity so much desired in the present case and, besides, a whole series of shades is lacking in the group. Mixture with other dyestuffs is of no use. Then, too, the use of chrome dyestuffs with Aniline Black gives rise to many technical difficulties.

With all the experience accumulated in attempts to solve these difficulties, it has, of course, long been a cherished goal to find a way of utilizing the vat dyestuffs for getting patterns upon the aniline black ground. The extended use of dyestuffs of this series was forbidden by the difficulty of fixing them completely under the aniline black. The possibility that they might dull the aniline black ground, or at least give rise to halos about the design, had also to be taken into consideration. As a matter of fact, it was not possible at first to use these colors successfully until Professor Haller succeeded in working out a process by which the dyestuff was printed with ferrous sulphate and suitable reserves and the goods, after "greening," developed by passage through a bath of caustic soda; the soluble Indigosols were also used by him. This process of Haller's is easy to carry through and gives good results. It has only two disadvantages: that we have not a satisfactory series of dyestuffs from which to choose and that the process is rather expensive. Printers have therefore been going back to the use of alkaline printing pastes and have found that the suspicions prevalent against the method are not justified.

If the alkali and the reducing agent are used only in the exactly calculated quantities, the vat dyestuffs can be fixed perfectly by the hydrosulphite method and without any harm to the fiber. On these facts is based the procedure of L. J. Roudenko, which was published in 1926. Of the large number of vat dyestuffs available, Indanthrene Yellow G (besides a few Indigoid dyestuffs) is particularly suitable, for it has the advantage of being capable of use in mixture with other dyestuffs very easily and it is, further, not sensitive toward alkali or toward steaming.

The following dyestuffs make it possible to produce a whole series of different tones: Scarlet KBN 50%, Thio-Indigo Red 2G (powder), Fuchsia KBN 30%, Thio-Indigo Red 2B (powder), Yellow KCN 30%, Indanthrene Yellow 2C, Blue CBN 30%, Brilliant Indigo 4B.

Since the mixing of Blue KBN and yellows gives only an olive-green, we should have had, for lively, pure green tones, to go to the sulphur dyestuffs; for example, Immedial Brilliant Green G Extra and Thiogen Green GL, lightly shaded with Indanthrene Yellow G. But since the appearance of the new pure Indanthrene Brilliant Greens GG and N, this is no longer necessary. If we desire a very bright orange, we mix Scarlet and Yellow KBN with about 40% of Helindone Orange R. The reduction of the vat dyestuffs, usually furnished in the powder form, is carried out with hydrosulphite. If the printing pastes made up with them are to be kept for a while, there must be added to them a little formaldehyde, but not too much, to prevent their spoiling. If for the reduction the formaldehyde derivative of hydrosulphite, and not plain hydrosulphite, has been used, a further addition of formaldehyde is not necessary, but the reduction of the dyestuff with that reducing agent proceeds with much greater difficulty, especially in the case of Helindone Orange R, Thio-Indigo Scarlet GG and Thio-Indigo Red B. The dyestuff is mixed, in the form of 20% paste, with phenol, glycerol and suitable finely ground thickening agents, to form the printing paste (except with Indanthrene Yellow C, Brilliant Indigo 4B and Sulphur Green, which reduce easily with hydrosulphite alone). The reduction of the sulphur dyestuffs is carried out by gentle warming of the mixture of dyestuff paste, cautsic soda, glycerol and the thickener at 50 to 55° for one to two hours. Then the necessary amount of hydrosulphite is added during one-half hour, with warming and stirring. The Indanthrene dyestuffs mentioned need for their reduction much less alkali than do the other Indanthrenes. Still, in using the dyestuffs of the KBN series, on account of the Indanthrene Yellow G used, we do have to add a little more alkali, otherwise we run the risk of incomplete fixation of the dyestuff. The development of the reserves and of the black is accomplished by a four-minute passage through the Mather-Platt in very damp steam at 101 to 101.5° C. With thin goods there is no danger of incomplete fixation of the reserves on account of the liberation of acid in the steaming, since even the reserves

themselves contain sufficient alkali to neutralize the acid. In the case of very heavy weaves, this possibility must be kept in mind, and we first pass the goods through an oxidation chamber (Preibisch) for one and one-half minutes, and then into the Mather-Platt. After steaming, the goods are treated full width with a warm solution of 15 g. of bichromate and 10 g. of acetic acid of 6° Bé. per liter. The full development of the black and the fixing of the vat dyestuff are thus accomplished at the same time. The results are finest upon mercerized cotton.

Aging of Alkali Cellulose

Berthold Rassow, Mell. Textil-Ber. 10, 787 (1929).—R. has studied carefully the effect of aging, for various lengths of time, cotton which has been treated with various strengths of caustic soda liquor under conditions chosen as standard. The results are given in tabular form; thirteen tables, covering the percentage of alpha-cellulose present, the copper number and hydrolysis number, pentosane content, hygroscopicity, N-content of nitration products, color, nature of film, and viscosity of the nitration products, viscosity of solutions of the nitration products aged in darkness, in daylight, and under the mercury-vapor arc, the hygroscopicity, decomposition point and "Verpuffungspunkt" of the nitration products, together with different aspects of acetylation products of the aged material. Concise comment upon the results obtained follow each table, and the article closes with nearly a page of summarized results. The article is of purely scientific interest only (at present), with no reference as yet to possible practical results, though work of this nature is always certain to be of value ultimately from the industrial side. The investigation is being continued.

Production of Ice Colors Upon Silk

German Patent No. 442,607; *I. G. Farbenindustrie A.-G.*—Refers to the production of Naphthol AS dyeings upon either raw or degummed silk. The Naphthol AS bath is prepared as usual with caustic soda; Turkey Red oil and a protective colloid, such as sulphite cellulose liquor, being also added. The developing is carried out as usual and the silk is not harmed in strength, luster or feel. Raw silk is degummed after dyeing and bleached with hydrogen peroxide, without, so it is stated, the dyed material being at all harmed. The results are said to be highly satisfactory as to fastness and brilliancy.

In one example given a padding bath is made up which contains 1 g. of Naphthol AS per liter, dissolved by means of 3 g. of caustic liquor of 34° Bé. and 2 g. of Turkey Red oil. One gram of sulphite cellulose liquor in solid form—i. e., 1 g. of the solid obtained by evaporating the liquor—is then added and the goods worked at 25 to 30° C. for twenty to twenty-five minutes; 10% of common salt on the weight of the goods is then dissolved in the bath and the goods worked for twenty minutes further. They are then thoroughly centrifuged, developed for ten to fifteen minutes in a diazo solution from 2.3 g. of 4-nitro-2- anisidine per liter, soured slightly with hydrochloric acid, thoroughly washed, soaped at almost the boiling point twice, for fifteen to twenty minutes each time, in a bath containing 4 to 5 g. of Marseilles soap per liter, then brightened warm and cold in a weak bath of acetic, formic, tartaric or sulphuric acid, and dried at not too high a temperature. A very fast scarlet is thus produced.

Treatment of Cotton for Dyeing with Acid Dyestuffs

German Patent No. 438,324; *Dr. Paul Karrer, Zurich.*—Cotton is partly esterified as usual with aryl-sulpho or alkyl-sulpho groups, as, for example, with benzene-, toluene- or naphthalene-sulphon chlorides, and then treated with ammonia, primary, secondary or tertiary amines, hydrazine or hydrazine derivatives, simple or in solution. One example cites the heating of ten parts of cotton, which has been partially esterified with toluene-sulphon chloride, for six hours with fifty parts of 25% ammonia-water, in the autoclave, at 100° C. Such a treated fiber can be dyed directly with ordinary acid dyestuffs.

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